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EDUCATION: "CIVIC" AND TECHNICAL.

A PHILOSOPHER'S definition of "patriotic feeling" ought to be very acceptable at the present day, when members of Her Majesty's Government are hurling "loop-holes" and similar missiles at the heads of their compatriots opposite. At the Lucerne Conference, Dr. Fleming said that "patriotic feeling" was not a mere exuberant enthusiasm, nor the singing of the National Anthem, nor the waving of the national flag; but it was the creation, first, of a scientific knowledge of the laws of the social organism—its laws of health and decay—and then of a disinterested desire and ability to aid in the re-establishment and maintenance of those conditions which determine the equilibrium constituting a healthy social state. "The organic unity of all human life," and the "attainment of social perfection," not for a limited group of individuals, but embracing the whole of the community—these were the broad principles underlying patriotism.

Dr. Fleming takes the word "civic" in its wider meaning, when applied to education. The defect of modern school education was the disproportionate value attached to the mere acquirement of information, and to the stocking of the memory with much that is really very useless. Tuition by examination was strongly to be denounced; it favoured only scholars having a sort of "elephantiasis" of the memory. From board-school to university was the ever-present examiner, with his sphinx-like questions and his examination paper, held pistol-fashion to the head of the unhappy candidate, who had to deliver up an answer or his life. That was evil in two directions: it checked originality and it diminished enthusiasm. Hence, instead of examining the *taught* to find out what they remembered, we ought to examine the *teacher* to find out how he imparted knowledge. There was much in the present system that was merely the burlesque of true education. Guyan had said: "It is not the information which is stored up as intellectual 'fat,' but that which is converted into intellectual 'muscle' which is useful." In practical life we were not often led into trouble by defective memory; but by defects of judgment, caution, and self-control. The Chinese, who had brought the examination system to the greatest perfection, were, of all races, the least progressive. A distinction had to be drawn between the *essential* and *ornamental* requirements of school systems. History, as at present taught, was largely made up of the deeds of kings and queens—together with their misdeeds. For civic purposes a child should learn the outline of events which had built up the constitution of the nations; consolidated true and popular liberties; and developed the resources and aspirations of the people. There ought to be no difficulty in teaching the facts of civic life, the functions of governmental departments, the elements of political and social economy, the duties of citizens, quite distinct from any party principles

or political bias, in a manner which should interest and excite attention. These should have a place in every school curriculum, under the term "Civics," as a subject of supreme importance.

If modern education is indeed so very defective, there are at least some signs of improvement in this lamentable state of affairs. The Department of Science and Art have sent to us an abstract of returns, showing the manner in which, and the extent to which, the councils of counties and county boroughs in England and Wales, and the county councils, town councils, and police commissioners of police burghs in Scotland, are devoting funds to the purposes of science and art, and for technical and manual instruction. It is a happy contrast to the somewhat pessimistical view taken by Dr. Fleming, in spite of the fact that the report is concerned principally with the "business" side of the scheme. In tabulated form it gives the amounts raised by rate under the Technical Instruction Act of 1889, the amount devoted to technical education out of the residue received under the Local Taxation (Customs and Excise) Act of 1890; and it further shows, in outline, the manner in which the funds have been disbursed. The residue received under the Local Taxation (Customs and Excise) Act in the County of London during 1892—94 is about £163,000, of which £87,000 has been devoted to technical education. The account of expenditure is, however, not set forth, the Council having delegated their powers to a joint committee (the Technical Education Board), which is considering the report prepared by Mr. Llewellyn Smith, to which we made reference some few months ago.

An examination of this report will show that technical education is now simply a matter for the people themselves to decide; the Government have given them the means if they will avail themselves of it; and it will be no fault of the Department if the various counties and burghs remain "untechnicated." Scotland is the slowest to appreciate the advantages of the scheme, and in more than half the Scottish districts the money seems to be devoted to the relief of the rates. Out of 220 such districts, only 36 apply the whole amount, raised under the "Residue" Act, to technical education; 39 districts are applying a part to that purpose; 119 are devoting it to the relief of the rates; 14 are still undecided; the other districts have sent in no report.

Every proposal for the improvement of the people must be examined as to its merits, in the first instance, in the larger towns; if it meets with success there, its provincial progress is certain. Manchester and Liverpool, Sheffield and Leeds are, with all the manufacturing county towns, setting examples to the rest of the country, which must ultimately excite the envy of those benighted districts where a fraction of a penny in the pound on the rates is being saved, to the degradation of the arts and industries of the whole nation. It is interesting to observe the wide range of the subjects taught in various parts of the kingdom. The little county of Rutland, for instance, spends something like £250 a year on teaching butter-making, cookery, drawing, sheep-shearing and hedge-cutting. Farriery is being taught in Oxford, political economy in Nottingham, fish-curing in Suffolk, bee-keeping in Wiltshire; the engineering classes being, of course, limited to the greater towns. The provincial districts have, in many instances, set apart a certain sum for the purpose of scholarships, and have thus enabled the more promising pupils to study at the central schools; this is an excellent way of furthering the scheme. The towns have had to bear the initial cost of erecting buildings, and much money has been usefully spent from the funds for this purpose. Bath has spent the whole amount received under the Act (£4,033) upon technical education. The sum of £1,000 has been applied to the maintenance of the schools and in discharging the liabilities of the former School of Art, the surplus money accumulating as capital towards the cost of a Central Institution. Another method of suitably applying the money has been carried into useful effect in Berkshire, where sums have been granted to the free libraries and museums for the purchase of books relating to technical instruction; this would be applicable to the very poorest districts, and where no greater attempt can be made to impart technical knowledge this at least should not be denied, even by the most scrupulous county councillors.

The Safety of Electric Lighting.

A SERIES of papers in which the causes of fires have been exhaustively dealt with has been running through the last few numbers of the *Journal of the Franklin Institute*, the author being Mr. C. John Hexamer. These articles ought to be carefully studied by insurance companies and by all firms and private individuals who are interested in the preservation of house property from the ravages of fire. The subject is treated in a masterly manner, and the paper exhibits a thorough acquaintance with the statistics of fires, however caused, throughout the world, but more especially in America. This is all the better for the sake of the moral we are about to point, for it is in America that electric lighting, and the use of electric energy generally, is most widely extended. Mr. Hexamer, after insisting upon the inherent danger of gas installations, and methods of illuminating by oil, and quoting piles of official reports to defend his statements, affirms plainly that the electric light is the safest system of illumination at present known. The only condition which can exist and weaken this safety is improper installation, and this, we assert, is every day becoming less likely to happen. With gas and oil, even when the fittings have been arranged by the most competent workmen, there is always danger which is due to the nature of the combustible. There is nothing inherently dangerous to electricity, provided it be properly installed. The chief points to be observed are proper insulation, good connections, suitable cut-outs, switches, &c., and, in the case of arc lamps, provision for the accidental fall of glowing carbons. In short, all that can be affirmed in regard to the safety of the electric light is entirely in its favour, and constitutes reasons for its more universal adoption Is it not time that insurance companies recognised these facts more completely, and gave some practical expression of them, *e.g.*, in the reduction of fire premiums on all buildings that are illuminated by the electric light?

Current Analysis.

M. BLONDEL has recently described a method of electrically determining the constituent waves in an alternating current. It consists in passing the current to be analysed through one coil of a dynamometer, and passing through the other coil a sine current whose periodicity can be made any even number of times that of the first current; the reading of the dynamometer then will enable the amplitude of the corresponding component of the original current to be calculated. It may be remembered that in a paper read before the Institution of Electrical Engineers, in March, 1889, entitled "Laboratory Notes on Alternate-current Circuits," by Professors Ayrton and Perry, the authors described a very similar method, the object of which, however, was not to measure the amplitude of any component, but merely to seek for its presence or absence. The details of M. Blondel's method are ingenious, and if it is ever necessary to get the information required, it would seem about the simplest to employ.

ON THE SWINBURNE-THOMPSON UNIT OF LIGHT.*

BY SILVANUS P. THOMPSON, D.Sc., F.R.S.

IN the spring of 1892 it was independently proposed by Mr. James Swinburne and by the author of this note, to adopt, as a unit of light of standard quality, the light emitted from a unit of area of the positive or crater surface of the electric arc formed between electrodes of pure carbon.

The advantages of this source of standard of illumination over all flame standards hitherto proposed, are so obvious as scarcely to need mention. The advantages over the platinum or Violle unit are also considerable. The carbon arc is much more easily managed, and if a pure carbon is employed, it is much more reliable as a standard than the mass of molten platinum.

The light of the electric arc is emitted, as is well known, chiefly from the end of the positive carbon, very little proceeding from the flame itself, and not much from the negative tip. Except at the edge parts, the light of the crater surface is of uniform lightness at every part if the carbon be pure. The reason of this circumstance is, as pointed out years ago by the writer, that carbon has a fixed temperature of volatilisation. The arc cannot be formed at all unless this temperature is reached at least at some portion of the surface; and the temperature cannot be exceeded at any point, simply because the volatilisation of the carbon keeps it down.

If an arc has been burning for some time, with a certain current, say 6 ampères, its crater will have assumed a certain shape or size. If we now increase the current to 12 ampères, the incandescent surface of the positive carbon will be at once increased in proportion, save for a slight discrepancy arising from the marginal effect of the duller parts, and the enlarged crater will settle down to a new shape. (These remarks relate to the steady arc; the phenomenon of the hissing arc being still very obscure). If, then, by proper shielding, there can be cut off all the stray light of uncertain quality emitted by the red-hot margin of the crater, that emitted by the negative tip and by the flame, so that only the true crater surface is visible, its whiteness, as so viewed through a hole in a suitable diaphragm, will always be of the same unvarying quality. This was the discovery of Captain Abney, F.R.S., in 1878; and it forms the basis of all the splendid work done by him in conjunction with Major-General Festing, F.R.S., on the photometry of colour.

Increasing the current merely increases the size of the crater, but does not alter its intrinsic brilliancy or its colour. Increasing the voltage of the arc has no effect on the intrinsic brilliancy or colour of the true crater surface. Increasing the length of the arc has no effect on the intrinsic brilliancy or colour of the true crater. The amount of light emitted from a square millimetre of crater surface is a fixed quantity, no matter how the current, or the voltage, or the length, may be varied; and not only is the total amount of light emitted from a square millimetre constant, but its composition is constant. That is to say, the proportion relatively of red waves to blue waves, is the same always, independent of current, voltage, or length of arc.

It was in consequence of the recognition of these physical properties of the true crater surface, that the writer and Mr. Swinburne each made the proposition for the establishment of a new unit to supersede the Violle standard. The author also referred to the recent work of Blondel and of Violle, which confirms his views, and also to that of Trotter, who found the light emitted (normally) from a square centimetre of hard carbon to be 70 candles.

Doubtless the imperfections of the photometric methods until recent years were such that the production of an exact standard of white light was of less importance than is now the case, since photometry has become an art of precision. Prof. Ayrton, adopting the periodic principle of photometry lately described by the author, and using a photometric screen of the Lummer-Brodhun pattern, finds no difficulty in measuring light with a precision of one part in 500. Now that such accuracy of measurement is possible, there is the more urgency for adopting a standard which is not only of entire trustworthiness, but is also easily reproduced.

* Abstract of a paper read before the International Electrical Congress, at Chicago, August, 1893.

FIRES IN CENTRAL STATIONS.

IN the matter of fires in central stations, our American friends can show a most remarkable record. There is no other country we know of where such disasters have been so numerous and destructive as in the United States. No wonder, therefore, the subject has received, and apparently continues to receive, great attention at the hands of American engineers and fire experts, as is evidenced by the number of papers read before various societies. Some of these we have previously noticed and commented upon; but a recent production of the kind, as published in the *Electrical Engineer* of New York, calls for some attention by those in charge of central stations, as dealing with a more important class of risk than any we have hitherto noticed. The author, Mr. William Brophy, speaks as a fire expert, and as one having considerable acquaintance with his subject. He not only deals with the construction and details of the stations destroyed—laying bare their weak points—but even suggests how other existing stations of the kind can be improved as fire risks.

We may safely assume that the burning of numbers of the early pioneer stations caused no surprise to those acquainted with their inferior construction and faulty arrangements. Their high rate of mortality (to borrow a term), can be easily accounted for quite apart from anything electrical. But when a number of more modern and well equipped stations followed suit, succumbing one after the other, fire office officials were fairly staggered; and when the veritable last straw came in the burning of the station at Elizabeth, N.J., a building regarded perfect even from a fire point of view, American central stations from that time forth were tabooed as something beyond the control of ordinary mortals. Various and amusing were the theories propounded to account for this alarming state of things. Needless to say, electricity had to bear the stigma. Ozone in the dynamo room was held responsible for the rapid spread of fire. The saturation of the building with positive and negative electricity was said to produce lightning discharges, and doubtless the electric "*fluid*" was deemed highly inflammable and considerably above proof.

Mr. Brophy has done well in relieving electricity to some extent of this slur by carefully sifting the evidence. Out of 10 important fires, only three can in any sense be attributed to electrical causes, and even in these cases the presence of combustible material in close proximity to overheated electrical appliances was the real evil. In all other instances fire was due to a combination of things in which electricity had no part, but in which faulty construction, misplaced matter in the shape of dirt, and negligence on the part of those employed, were potent factors.

It is strange to read of "fire-proof stations" having exposed woodwork in their engine and dynamo rooms. Such places are usually pretty warm, not to say hot, hence woodwork therein is liable to become highly dried, and highly dried wood may be regarded as exceedingly dangerous. Then, again, we read of neglected workshops and lumber rooms under the same roof, where sooner or later the inevitable fire breaks out from some unknown cause. In every instance the destruction was rapid and complete, so far, at least, as the contents of these stations were concerned.

The destruction of a large and important central station is a very serious matter for all concerned. In addition to the heavy pecuniary loss, there is the inconvenience and annoyance suffered by numerous consumers in being deprived of their supply for a considerable time, greatly to the detriment of the lighting interest.

The immunity of our large supply companies from such disasters speaks well for the architects and engineers. But it behoves those in charge of such stations to thoroughly overhaul their buildings with a view to discover any such defects as those we have indicated, in order that they may be removed, and thus prevent disaster. Exposed woodwork, in the shape of partitioning and linings, stands condemned. Every electrical apparatus within the building, from the dynamo down to the smallest switch, should be regarded as a firebrand, and care taken that nothing of a combustible nature is within its reach. It is a fallacy to suppose a fire cannot spread in an engine room, however well built; and it is equally a fallacy to imagine so-called "fire-proof"

stations cannot burn. Though the main structure may suffer comparatively little damage, the contents of the dynamo room may, nevertheless, be destroyed, as was actually the case at the Boston station of the Edison Company.

Forewarned is forearmed. Let us, therefore, not neglect to profit by the experience of our neighbours.

MODERN GAS AND OIL ENGINES.*

SEVENTH PAPER.

MR. SPIES continues his series of articles in *Cassier's Magazine*. In his seventh paper he says that for launch work the Pacific engine has been much employed; always running in one direction, reversal of the propeller is by gearing. It is a vertical engine using the Otto cycle. The Union engine, of similar type by the same builders, is a horizontal engine. They have both an exhaust valve which is maintained open during non-explosive cycles, and electric ignition is used.

The Stockport engine, of Messrs. Andrew & Co., of Stockport is described. In its present form this is practically a modified Crossley engine, but it runs at a high speed, and the writer has found them to give excellent and steady turning. The smaller engines have an inertia or vibrating governor which seems very sensitive, and a tube igniter with a time valve. This type of engine has been built to give as much as 150 I.H.P. The Morecambe electric light installation is driven by three, of 16 H.P. each, with Dowson gas plant.

Messrs. Tangye Bros. have placed a 115 H.P. engine in a Belfast Mill, and Messrs. Crossley Bros. have also built engines of 100 H.P. The large engines require starting devices of which one, the Clerk-Lanchester, is described, and is, in brief, an external chamber into which gas and air are admitted and exploded, whereby a similar mixture in the cylinder is compressed until it ignites in the usual way and the engine starts. This method was fully described by us a week or two ago.

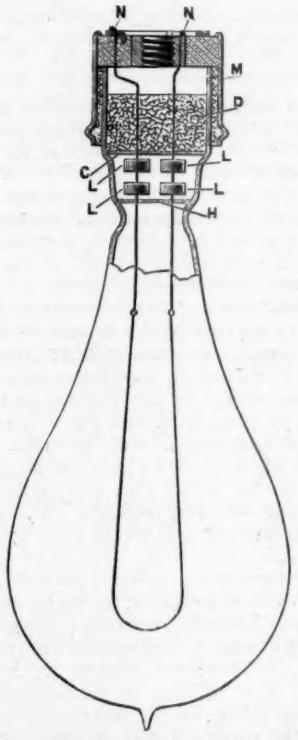
In petroleum engines a modified Capitaine engine is seen in the oil engine of J. M. Geole & Co., of which many have been sold in less than the three years during which it has been on the market. Oil is vaporised before passing to the cylinder, and the amount of oil is regulated by the governor. The oil used is ordinary lighting oil, and the Otto cycle is worked, ignition being secured on the compression of part of the vaporised oil, and air being forced back into the hot vaporiser, which thus serves as an ignition tube.

So far as the descriptions thus given may be taken as evidence, the Otto cycle seems to be gradually displacing all other methods of working, and it certainly appears to give a simpler looking piece of machinery generally. Mr. Spies has not yet concluded his descriptions, and may have something to tell us yet of special novelty.

THE NEW BEACON NON-INFRINGING INCANDESCENT LAMP.

THE Beacon Vacuum Pump and Electrical Company of Boston is very enterprising. It first obtained celebrity in connection with a mechanical pump used for exhausting lamp bulbs; the claim being made that its lamps did not blacken nearly so rapidly as those exhausted by mercury pumps. Next it obtained world-wide renown by bringing forward the "Goebel Defence," and now it is again seeking to continue its existence and notoriety by bringing out a new kind of incandescent lamp. This lamp is not claimed to be a "detachable" lamp, though it is constructed on somewhat similar lines, a special fusible cement being used to fill up the neck of the bulb, and support the leading-in wires. Besides the special cement (which, like the wonderful primary battery solutions one hears of from time to time, is naturally kept a secret) the only claims to novelty consist in the means adopted to disperse the heat in the neck of the bulb, whereby the fusion of the cement is prevented.

A glance at the figure will make almost everything clear, excepting the nature of the cement. C and H, are two mica discs which rest on shoulders formed in the neck of the bulb, the discs being perforated to admit the leading-in wires, which are of iron. The disc, H, acts as a reflector, whilst the one more removed serves both as a reflector and a support for the cement, D. L, L, L, L, are small bodies of metal attached to the leading-in wires in the space between the discs, and are designed for the purpose of acting as dispersers of the heat taken up by the wires, and thus assist in keeping the neck cool. M and N represent the indispensable appendage of almost every form of incandescent lamp in use—the cap and terminal contacts.



It goes without saying that the success of the lamp, under existing circumstances, hinges almost entirely on the suitability of the sealing compound. This must be cheap and thoroughly efficient in preventing leakage. With these conditions granted, the lamp could, no doubt, hold its own during the existence of the Edison patent. The question, however, of reverting to the classical plan of sealing wires directly into the bulbs is, we should imagine, likely to be reconsidered by the officials as soon as the master patent lapses, in spite of the present contention that lamps made in the new style are cheaper to manufacture than those in the old. The labour and materials requisite for making the perforated mica discs, the metal radiators fixed to the leading-in wires, the cement, and the arranging of these articles together, are all *additional* items and they would have, in competing with the customary lamp, to be provided for out of the saving made in platinum wire, *i.e.*, about a penny per lamp. The labour expended in sealing-in does not enter into the calculation as it would be about balanced by that required for making the necessary shoulders in the lamp bulbs of the new type. If the operation of reconstructing a worn out lamp were a simple matter (as is claimed with the Westinghouse stopper lamp) the conditions, as regards the probable permanence of the new type would be materially altered, but there is no claim made to this effect in the account of the lamp and its inventors, Messrs. Wm. E. Nickerson and Edw. E. Cary, given in the New York *Electrical Engineer* for August 23rd.

In making these remarks, we are not incapable of recognising and appreciating the ingenuity and able manner in which these inventors have handled the question of devising a technically non-infringing incandescent lamp. The problem is certainly no easy one, and we heartily wish the cement lamp every success. It seems to us, further, that if the Beacon Company is in possession of a cement which

* Our readers will find this, and previous papers, given fully in *Cassier's Magazine*.

will really adhere hermetically to glass it is to be congratulated, as it should prove valuable in various industries, even if it should have eventually, for the sake of economy, to be discontinued in the lamp industry.

We note that the Beacon Company is willing to grant licenses under royalty to other lamp manufacturers; and it is stated that the new lamps have been on the market for some months, and have given the utmost satisfaction. At the present time there are upwards of 50,000 in actual use.

THE UTILISATION OF TOWN REFUSE FOR POWER PRODUCTION.

BY THOMAS TOMLINSON, B.E., Assoc.M.Inst.C.E.

(*Continued from page* 303.)

IF the destructor is to deal with a mixture of ashbin refuse and sludge (as at Ealing and Leyton), say in the proportion of two of ashbin refuse to one of pressed or dried sludge (which is about the proportion in which we may expect them to be yielded by an ordinary population), the method to be adopted would be as follows: The ashbin refuse (not less than 14 tons) would be thoroughly mixed and divided into two equal parts by weight, the sludge (7 tons say), would be also divided into two equal parts by weight; three heaps would then be made, one ashbin refuse and sludge mixed, the second ashbin refuse alone, the third sludge alone; the first heap would be treated in the destructor, and the boiler evaporation measured; the second would be retorted and the fuel weighed and water estimated, the fuel being afterwards burned under the boiler or in the destructor, according as the formula for the destructor or for the plant was required, and the boiler evaporation measured; the third would be retorted, the solids weighed and the water measured (really part only need be retorted since the composition of sludge may be taken as uniform throughout); from the first we would get f per ton of mixed stuff, from the second we would get F per two-thirds of a ton of ashbin refuse, w would be got by adding together the contained water per two-thirds of a ton of ashbin refuse, and the contained water per one-third of a ton of sludge from the retorting of heaps 2 and 3, and G would be one-third of the solids per ton of sludge from the retorting of part or the whole of heap 3 (this assumes that the average amount of detritus and materials used for precipitations is proportional to the other solids precipitated from the sewage, which is a not unfair assumption); from four such experiments the formula for the destructor when dealing with ashbin refuse and sludge in *definite proportions* could be obtained.

As I know of no instance in which midden stuff is destroyed, or proposed to be destroyed in an open destructor, it is not necessary to consider the manner of proceeding to obtain the constants in the formula in this case.

Returning now to the consideration of the return to be expected from midden refuse, in the light of the experiments I have before described, it is obviously necessary to get at the quantity with which we have to deal; I have been able to get only two figures. At Wakefield Mr. Whittaker has informed me they collected last year 7,914 loads, this we may take at about 8,000 tons in weight, and according to the figures already obtained with the retort destructor, would yield over and above the fuel necessary for its destruction, 550 tons of cinders and 1,100 tons of breeze. It may be pretty safely surmised (though, of course, it lacks the authority attaching to an actually attained result), that with grate bars provided in the boiler and furnaces suitable for burning the breeze alone, and with the economy which would result from grouping the retorts, there would be available at least 1,000 tons of cinders, say 12 per cent. of the total weight treated, even allowing for the provision of the power necessary to perform by machinery those operations which in the trials were done by hand.

A clever engineer friend of mine has criticised the results obtained by me with the retort destructor (and on which the above is based), from the point of view of the labour required to charge into and discharge from the retorts 40 or 50 tons a day by hand. I conclude, therefore, that I have not made it sufficiently plain that the plant experimented on was purely experimental.

Even if it were possible for me, while taking every pains to get at the quantity and bulk of the material to be treated, to overlook the labour entailed in dealing with such large quantities by hand, it would in this case have been rendered impossible by the fact that Mr. Hanson had plans and sketches showing the proposed method of dealing with large quantities, in which the hand labour was reduced to the stoking of the furnaces (one to three or more retorts), with the obvious inference that, as breeze lends itself to mechanical stoking, even this operation, like the charging, discharging and riddling, could be made continuous and automatic.

I should not have considered it necessary to mention this, if the possibility of the misunderstanding had not been brought to my notice, because these articles are not on the design of destructors, but on the results obtainable from them in the form of power.

Through the courtesy of Mr. Hewson, M.I.C.E., City surveyor of Leeds, and of Mr. Darley, the superintendent of this particular department, I am enabled to give the figures for that town—37,000 tons from January 1st to December 31st, 1892. This quantity would yield about 4,500 tons of cinders.

At Wakefield, at any rate (and generally, I think, in towns which have a midden system), there is also a pail system: At Wakefield 83,250 tubs, each containing, say, 1·75 cubic feet, or a total of 5,396 cubic yards, were collected last year. Towards dessicating this and making it inodorous, there would be about 5,000 cubic yards of carbon dust available from the midden refuse if it were found suitable for the purpose.

Coming now to sludge, obviously any return as power from its destruction, and, indeed, the possibility of its destruction, must depend mainly upon the contained gas, and in a lesser degree (owing to its presence in a very finely divided state) upon the contained carbon. It is, therefore, of extreme importance to ascertain the quantity and quality of this contained gas.

Fortunately, sludge can be readily experimented with on a small scale, and, owing to the conditions of its precipitation, the thorough mixing it undergoes in the process, and in the subsequent sweeping from the tanks, conclusions drawn from such small scale experiments will hold good for large quantities.

For the purpose of experimenting with the material, I made use of very simple appliances, and with similar appliances any one may satisfy himself as to the quantity of gas produced and as to certain of its characteristics, which are of importance in considering its possible utilisation or destruction. Take two pieces of ¾ inch gas tube, screwed at each end, and 24 inches and 21 inches long over all; take two connecting tees, the middle branch of each being for ¾ inch pipe, and the two side branches for ¼ inch pipe; screw into the ¼ inch branches four lengths of ¼ inch pipe each 6 inches long, of which two (one in each tee) are to have gas taps; screw the tee pieces on to the ¾ inch pipes, and you will have two T's, the head of each being 12 inches across, and the stems 24 inches and 21 inches; now connect the bottom ends of the two stems with a pair of elbows and a short piece of ¾ inch screwed pipe, the T's lying parallel one to the other. You can now charge the ¾ inch tubes with broken up sludge cake by unscrewing the connecting tees, and when they are screwed up, the stems of the two tees can be thrust between the bars of any range, the T's lying vertically, with the gas cocks (which are to allow condensed water to be drawn off) lying downwards. After a very short time (5 to 10 minutes), gas will be given off from the sludge, and may be led away from the two open ends of the ¼-inch tubes by ordinary rubber tubing, and may be collected over water in an inverted glass vessel in the ordinary way. I have usually used 1½ ozs. of sludge in each experiment, and for this you require as a collecting vessel, a jar, preferably of glass, of one gallon capacity. It will be found that such a jar will be filled, or nearly so, with the gas given off from 1½ ozs. of fresh pressed sludge. To burn this gas, provide an ordinary galvanised iron bucket with a gas cock and burner, fixed in the bottom outside; the gas from the collecting jar can be transferred under water to the bucket, and the gas can then be forced out through the burner by depressing the bucket; the gas will be found to burn readily, but its lighting

power will be found to vary with sludges from different districts; its lighting value, however, does not concern us, only its heating, and this I hope shortly to roughly estimate as compared with coal-gas.

A few experiments will demonstrate several facts of importance in dealing with this material:—

1. Quantity: From 1½ ozs. you can get a gallon measure, *i.e.*, 0·16 cubic feet: this is 3,800 cubic feet per ton of pressed sludge.

Mr. Lomax, of Nelson, in his "Collection, Treatment and Disposal of Town Refuse," records an experiment made by him on a ton of *pressed* sludge reduced to 13 cwt. 3 lbs. of *dried* sludge by evaporation in what he calls a "revivifier," and then retorted at a gas works. He states the yield to be from 4,500 to 5,000 cubic feet per ton of *dried* sludge, which is 3,000 to 3,300 cubic feet per ton of *pressed* sludge.

2. Quality: This I have not yet determined, but Mr. Lomax states the candle-power to have been 22 C.P. as a maximum, and to have averaged 16·75 C.P.; the candle-power does not concern us, except in so far as it indicates roughly a value about equal to coal-gas for lighting, and possibly for heating. In the "Purification of Water carried Sewage," by Robinson and Melliss, there is mention of certain experiments carried out at Coventry, and it is stated that "the illuminating power of the gas was small, although the heating power was considerable."

3. General characteristics: The gas is given off at a low temperature 5 to 10 minutes after the tubes are placed in the fire; it is given off very rapidly, all within 10 to 15 minutes from beginning to come over; it stinks vilely, but burns inodorously; when first collected it is white and smoky, but in a short time it clears and becomes colourless, a light yellow deposit forming in the receiver; its volume decreases very slightly after prolonged cooling, so it may be taken as permanent; the yield from a given quantity of sludge diminishes rapidly as the sludge is kept (especially if it be broken up and exposed to the air).

The experiments indicated are all supposed to be made with *pressed* sludge; if crude sludge, as swept from the tanks, be used, the resulting gas will not ignite, nor will the gas from midden or pail stuff.

Every ten tons of sludge, as swept from the tanks, consists approximately of

Water	...	...	9 tons
Solids	...	...	1 ton

This sludge when pressed into cakes loses 8 tons of water and then consists approximately of

Water	...	...	1 ton
Solids	...	...	1 „

The difference, then, between the gas as given by the unpressed and pressed sludge, lies in the gas contained in the press liquor. To ascertain the nature of this gas, put a small quantity, say 1 pint, in a kettle with close lid (what is called a bronchitis kettle is the handiest). It will be found that on applying heat gas is given off; that it is given off at a very low temperature; that it is given off with extreme rapidity; that it is very small in amount, and that it does not ignite. In an actual experiment with one pint, the gas began to be given off in five minutes, and was all given off in twenty minutes, and the quantity from one pint was about 0·02 cubic feet, equal to about 60 cubic feet per ton of press liquor. The obvious deduction appears to be that the gases which do not ignite are soluble in water and are carried away in the press liquor, and that though small in amount they yet have power to neutralise the much larger amount of gases which will ignite, if present beyond a certain percentage, in a manner precisely analogous to the reduction in light-giving power produced by a small proportion of atmospheric air in coal gas, a reduction out of all proportion to the quantity of air present.

The consideration of the bearing of these facts upon the destruction of sludge, and the possibilities of return therefrom, will be considered in the next article.

(To be continued.)

The Electric Light at Ryde.—The Town Council have determined to apply for sanction to raise money for the purpose of electric lighting.

THE BRITISH ASSOCIATION.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

Report of the Committee, consisting of Prof. CAREY FOSTER (*Chairman*), Lord KELVIN, Profs. AYRTON, J. PERRY, W. G. ADAMS, *and* Lord RAYLEIGH, Drs. O. J. LODGE, JOHN HOPKINSON, *and* A. MUIRHEAD, Messrs. W. H. PREECE *and* HERBERT TAYLOR, Profs. J. D. EVERETT, *and* A. SCHUSTER, Dr. J. A. FLEMING, Profs. G. F. FITZGERALD, G. CHRYSTAL, *and* J. J. THOMSON, Messrs. R. T. GLAZEBROOK (*Secretary*), W. N. SHAW, Dr. J. T. BOTTOMLEY, *and* T. C. FITZPATRICK, Prof. J. VIRIAMU JONES, Dr. G. JOHNSTONE STONEY, Prof. S. P. THOMPSON, *and* Mr. G. FORBES.

(*Presented to Section A, September 19th*, 1893.)

THE work of testing resistance coils at the Cavendish Laboratory has been continued. A table of the coils tested is given. They have all been "ohms," as defined by the resolution of the Committee given in their last report, and since adopted by the Board of Trade Committee on electrical standards in the following form:—

The resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass, of a constant cross-sectional area, and of a length of 106·3 centimetres, may be taken as 1 ohm. The relation between the B.A. unit and the ohm is the following:—

1 B.A. unit = ·9866 ohm.

TABLE I.

Ohms.

No of coil.			Value in ohms.	Temperature.
Nalder, 3,717	...	C.L.C. No. 361		
Nalder, 3,874	...	„ No. 362	9·9926	14·9°
Nalder, 3,059*	...	„ No. 326	1·00000	16·5°
Nalder, 3,633	...	„ No. 363	100·000	17·2°
Nalder, 3,637	...	„ No. 364	100·060	17·05°
Nalder, 3,635	...	„ No. 365	1,000·00	17·3°
Nalder, 3,872	...	„ No. 366	9·9947	14·9°
Nalder, 3,873	...	„ No. 367	9·9919	14·8°
Nalder, 4,085	...	„ No. 368	·99889	14·8°
Nalder, 3,263	...	„ No. 369	·99895	14·2°
Warden, 1,866	...	„ No. 370	1·00080	14·5°
Warden, 1,918	...	„ No. 371	1·00041	14·3°
Nalder, 3,715	...	„ No. 372	·99944	13·5°
Nalder, 3,719	...	„ No. 373	·99907	13·3°
Nalder, 3,720	...	„ No. 374	·99893	13·3°
Nalder, 3,633	...	„ No. 375	9·9910	15·3°
Nalder, 3,876	...	„ No. 376	·99932	15·2°
Nalder, 3,981	...	„ No. 377	10·0001	15·7°
Nalder, 4,086	...	„ No. 378	·99978	15·9°
Elliott, 303	...	„ No. 379	1·00054	18·2°
Elliott, 304	...	„ No. 380	1·00052	18·1°

* This coil has been tested before.

The resolutions adopted by the committee at Edinburgh were communicated to the Electrical Standards Committee of the Board of Trade. After consideration the Board of Trade Committee drew up an amended report, in harmony with the Edinburgh resolutions, for presentation to the President (see Appendix I.).

The resolutions were accepted at Edinburgh by Dr. von Helmholtz on behalf of Germany, while in France an official committee decided last June to adhere to the propositions of the Board of Trade. Austria and Italy are connected by treaty with Germany for telegraph purposes, and in consequence adopt the same units.

Tests have been made during the year on the 1-ohm and 10-ohm standards of the Association. These are still being continued. The 100-ohm and 1,000-ohm standards have now been delivered, and the tests will be shortly proceeded with. Some experiments were made as to the amount of heating in the coils produced by the current used for testing. These are detailed in Appendix II. Further valuable information on this point is contained in Mr. Griffiths's paper on "The Value of the Mechanical Equivalent of Heat."*†

The committee think it desirable that they should be in a position to complete the set of resistance standards of the Association, and recommend, therefore, that they be reappointed, with a grant of £25, that Professor G. Carey Foster be Chairman, and Mr. R. T. Glazebrook Secretary.

The committee have learned with pleasure from Mr. W. H. Preece, one of the English delegates to the International Congress of Electricians at Chicago, that the Congress has accepted a series of resolutions defining the fundamental units, practically identical with the Edinburgh resolutions. Thus these resolutions have now been accepted as a basis for legislation throughout the British Empire, the whole of Western Europe, and the United States of America.

The committee are also informed that the Chicago Congress have adopted the name, "Henry," for the unit of self-induction.

While looking with favour on this suggestion, they think it desirable to postpone definite action until the official report of the Congress has been received.

In March, M. Mascart wrote to the secretary, asking the opinion of

* *See* ELECTRICAL REVIEW, August 11th, 1893. † *Phil. Trans.*, 1893.

the committee as to a name for the standard of resistance defined at Edinburgh. A circular letter was issued inviting members of the committee to express their views on four names which had been suggested, viz., international, normal, étalon, or "ohm de 1893." After receiving replies to the circular from twelve members of the committee, the secretary wrote to Prof. Mascart to the effect that the number of members who expressed a preference for the name, international, was greater than the number declaring in favour of any other name, but that he thought that the committee would accept whichever of the first three suggestions commended itself to the French committee appointed to deal with the matter.

During the year, Dr. Muirhead has remeasured his standard condenser. He now finds as the capacity of a condenser, constructed 23 years since, to represent ·1 microfarad (B.A.U.), the value ·09998 microfarad.

APPENDIX I.

SUPPLEMENTARY REPORT OF THE ELECTRICAL STANDARDS COMMITTEE OF THE BOARD OF TRADE.

To the RIGHT HON. A. J. MUNDELLA, M.P., *President of the Board of Trade.*

Subsequently to the presentation of our former report to Sir Michael Hicks-Beach, in July, 1891, we were informed that it was probable that the German Government would shortly take steps to establish legal standards for use in connection with electrical supply, and that, with a view to secure complete agreement between the proposed standards in Germany and England, the Director of the Physico-technical Imperial Institute at Berlin, Professor von Helmholtz, with certain of his assistants, proposed to visit England for the purpose of making exact comparisons between the units in use in the two countries, and of attending the meeting of the British Association which was to take place in August in Edinburgh.

Having regard to the importance of this communication it appeared desirable that the Board of Trade should postpone the action recommended in our previous report until after Professor Helmholtz's visit.

That visit took place early in August, and there was a very full discussion of the whole subject at the meeting of the British Association in Edinburgh, at which several of our number were present. The meeting was also attended by Dr. Guillaume, of the Bureau International des Poids et Mesures, and Professor Carhart, of the University of Michigan, U.S.A., who were well qualified by their scientific attainments to represent the opinion of their respective countries.

It appeared from the discussion that a few comparatively slight modifications of the resolutions included in our previous report would tend to secure international agreement.

An extract from the report of the Electrical Standards Committee of the British Association embodying the results of this discussion was communicated to us by the secretary, and will be found in the appendix to this report.

Having carefully reconsidered the whole question in view of this communication, and having received the report of the sub-committee mentioned in resolution 14 of our previous report, we now desire, for the resolutions contained in that report, to substitute the following:—

RESOLUTIONS.

1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by Her Majesty in Council as Board of Trade standards.
2. That the magnitudes of the standards should be determined on the electro-magnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.
3. That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second.
4. That the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross-sectional area, and of a length of 106·3 centimetres, may be adopted as 1 ohm.
5. That a material standard, constructed in solid metal, should be adopted as the standard ohm, and should from time to time be verified by comparison with a column of mercury of known dimensions.
6. That, for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm.
7. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and sub-multiples of the ohm.
8. That the value of the standard of resistance constructed by a committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm.
9. That the standard of electrical current should be denominated the ampère, and should have the value one-tenth (0·1) in terms of the centimetre, gramme, and second.
10. That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second may be taken as a current of 1 ampère.
11. That an alternating current of 1 ampère shall mean a current such that the square root of the time average of the square of its strength at each instant in ampères is unity.
12. That instruments constructed on the principle of the balance, in which, by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current, whether unvarying or alternating.
13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampère.
14. That the electrical pressure at a temperature of 15° Centigrade between the poles or electrodes of the voltaic cell known as Clark's cell, prepared in accordance with the specification attached to this report, may be taken as not differing from a pressure of 1·434 volt by more than one part in one thousand.
15. That an alternating pressure of 1 volt shall mean a pressure such that the square root of the time-average of the square of its value at each instant in volts is unity.
16. That instruments constructed on the principle of Lord Kelvin's quadrant electrometer used idiostatically, and for high pressures, instruments on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating.

(Signed) COURTENAY BOYLE.
KELVIN.
P. CARDEW.
W. H. PREECE.
RAYLEIGH.
G. CAREY FOSTER.
R. T. GLAZEBROOK.
J. HOPKINSON.
W. E. AYRTON.

(Signed) T. W. P. BLOMEFIELD,
Secretary.

November 29th, 1892.

SPECIFICATION REFERRED TO IN RESOLUTION 10.

In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time-average of the current, or if the current has been kept constant, the current itself can be deduced.

In employing the silver voltameter to measure currents of about 1 ampère the following arrangements should be adopted. The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 centimetres in diameter, and from 4 to 5 centimetres in depth.

The anode should be a plate of pure silver some 30 square centimetres in area, and two or three millimetres in thickness.

This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing wax.

The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate, to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of Making a Measurement.

The platinum bowl is washed with nitric acid and distilled water dried by heat, and then left to cool in a desiccator. When thoroughly dry it is weighed carefully.

It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support to which a binding screw is attached. This copper support must be insulated.

The anode is then immersed in the solution, so as to be well covered by it, and supported in that position; the connections to the rest of the circuit are made.

Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half an hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval.

The solution is now removed from the bowl and the deposit is washed with distilled water and left to soak for at least six hours. It is then rinsed successively with distilled water and absolute alcohol and dried in a hot-air bath at a temperature of about 160° C. After cooling in a desiccator it is weighed again. The gain in weight gives the silver deposited.

To find the current in ampères, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed and by ·001118.

The result will be the time-average of the current, if during the interval the current has varied.

In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instrument taken at frequent observed intervals of time. These observations give a curve from which the reading corresponding to the mean current (time-average of the current) can be found. The current, as calculated by the voltameter, corresponds to this reading.

SPECIFICATION REFERRED TO IN RESOLUTION 14.

Definition of the Cell.

The cell consists of zinc and mercury in a saturated solution of zinc sulphate and mercurous sulphate in water, prepared with mercurous sulphate in excess, and is conveniently contained in a cylindrical glass vessel.

Preparation of the Materials.

1. *The Mercury.*—To secure purity it should be first treated with acid in the usual manner, and subsequently distilled in vacuo.

2. *The Zinc.*—Take a portion of a rod of pure redistilled zinc, solder to one end a piece of copper wire, clean the whole with glass paper, carefully removing any loose pieces of the zinc. Just before making up the cell dip the zinc into dilute sulphuric acid, wash with distilled water, and dry with a clean cloth or filter paper.

3. *The Zinc Sulphate Solution.*—Prepare a saturated solution of pure ("pure recrystallised") zinc sulphate by mixing in a flask of distilled water with nearly twice its weight of crystals of pure zinc sulphate, and adding zinc oxide in the proportion of about 2 per cent. by weight of the zinc sulphate crystals to neutralise any free acid.* The crystals should be dissolved with the aid of a gentle heat, but the temperature to which the solution is raised should not exceed 30° C. Mercurous sulphate, treated as described in 4, should be added in the proportion of about 12 per cent. by weight of the zinc sulphate crystals, and the solution filtered, while still warm, into a stock bottle. Crystals should form as it cools.

4. *The Mercurous Sulphate.*—Take mercurous sulphate, purchased as pure, and wash it thoroughly with cold distilled water by agitation in a bottle; drain off the water and repeat the process at least twice.* After the last washing drain off as much of the water as possible.

Mix the washed mercurous sulphate with the zinc sulphate solution, adding sufficient crystals of zinc sulphate from the stock bottle to ensure saturation, and a small quantity of pure mercury. Shake these up well together to form a paste of the consistence of cream. Heat the paste, but not above a temperature of 30° C. Keep the paste for an hour at this temperature, agitating it from time to time, then allow it to cool; continue to shake it occasionally while it is cooling. Crystals of zinc sulphate should then be distinctly visible, and should be distributed throughout the mass; if this is not the case add more crystals from the stock bottle, and repeat the whole process.

This method ensures the formation of a saturated solution of zinc and mercurous sulphates in water.

Contact is made with the mercury by means of a platinum wire about No. 22 gauge. This is protected from contact with the other materials of the cell by being sealed into a glass tube. The ends of the wire project from the ends of the tube; one end forms the terminal, the other end and a portion of the glass tube dip into the mercury.

To set up the Cell.

The cell may conveniently be set up in a small test tube of about 2 centimetres diameter, and 6 or 7 centimetres deep. Place the mercury in the bottom of this tube, filling it to a depth of say, 1·5 centimetre. Cut a cork about ·5 centimetre thick to fit the tube; at one side of the cork bore a hole through which the zinc rod can pass tightly; at the other side bore another hole for the glass tube which covers the platinum wire; at the edge of the cork cut a nick through which the air can pass when the cork is pushed into the tube. Wash the cork thoroughly with warm water, and leave it to soak in water for some hours before use. Pass the zinc rod about 1 centimetre through the cork.

Clean the glass tube and platinum wire carefully, then heat the exposed end of the platinum red-hot and insert it in the mercury in the test tube, taking care that the whole of the exposed platinum is covered.

Shake up the paste and introduce it without contact with the upper part of the walls of the test tube, filling the tube above the mercury to a depth of rather more than 2 centimetres.

Then insert the cork and zinc rod, passing the glass tube through the hole prepared for it. Push the cork gently down until its lower surface is nearly in contact with the liquid. The air will thus be nearly all expelled, and the cell should be left in this condition for at least 24 hours before sealing, which should be done as follows:—

Melt some marine glue until it is fluid enough to pour by its own weight, and pour it into the test tube above the cork, using sufficient to cover completely the zinc and soldering. The glass tube should project above the top of the marine glue.

The cell thus set up may be mounted in any desirable manner. It is convenient to arrange the mounting so that the cell may be immersed in a water-bath up to the level of, say, the upper surface of the cork. Its temperature can then be determined more accurately than is possible when the cell is in air.

In using the cell sudden variations of temperature should as far as possible be avoided.

Notes.

The Zinc Sulphate Solution.—The object to be attained is the preparation of a neutral solution of pure zinc sulphate saturated with $ZnSO_4 7H_2O$.

At temperatures above 30° C. the zinc sulphate may crystallise out in another form; to avoid this 30° C. should be the upper limit of temperature. At this temperature water will dissolve about 1·9 time its weight of the crystals. If any of the crystals put in remain undissolved they will be removed by the filtration.

The amount of zinc oxide required depends on the acidity of the solution, but 2 per cent. will, in all cases which will arise in practice with reasonably good zinc sulphate, be ample. Another rule would be to add the zinc oxide gradually until the solution became slightly milky. The solution when put into the cell should not contain any free zinc oxide; if it does then, when mixed with the mercurous sulphate, zinc sulphate and mercurous oxide are formed; the latter may be deposited on the zinc, and affect the electromotive force of the cell. The difficulty is avoided by adding, as described, about 12 per cent. of mercurous sulphate before filtration: this is more than sufficient to combine with the whole of the zinc oxide originally put in, if it all remains free; the mercurous oxide formed together with any undissolved mercurous sulphate is removed by the filtration.

The Mercurous Sulphate.—The treatment of the mercurous sulphate has for its object the removal of any mercuric sulphate which is often present as an impurity.

Mercuric sulphate decomposes in the presence of water into an acid and a basic sulphate. The latter is a yellow substance—turpeth mineral—practically insoluble in water: its presence, at any rate in moderate quantities, has no effect on the cell. If, however, it is formed the acid sulphate is formed also. This is soluble in water and the acid produced affects the electromotive force. The object of the washings is to dissolve and remove this acid sulphate, and for this purpose the three washings described in the specification will in nearly all cases suffice. If, however, a great deal of the turpeth mineral is formed it shows that there is a great deal of the acid sulphate present, and it will then be wiser to obtain a fresh sample of mercurous sulphate rather than to try by repeated washings to get rid of all the acid.

The free mercury helps in the process of removing the acid, for the acid mercuric sulphate attacks it, forming mercurous sulphate and acid which is washed away.

The cell may be sealed in a more permanent manner by coating the marine glue, when it is set, with a solution of sodium silicate and leaving it to harden.

* See Notes.

APPENDIX.

August 12th, 1892.

DEAR SIR,—I am desired by the Electrical Standards Committee of the British Association to communicate to the Electrical Standards Committee of the Board of Trade the enclosed extract from their report made to the Association on August 9th, 1892.

I remain, yours faithfully,

(Signed) R. T. GLAZEBROOK,

Secretary, Electrical Standards Committee of the British Association.

To Sir Thomas Blomefield,

Secretary, Electrical Standards Committee of the Board of Trade.

EXTRACT FROM THE REPORT OF THE ELECTRICAL STANDARDS COMMITTEE OF THE ASSOCIATION, AUGUST 9TH, 1892.

The following resolutions were agreed to:—

1. That the resistance of a specified column of mercury be adopted as the practical unit of resistance.

2. That 14·4521 grammes of mercury in the form of a column of uniform cross-section 106·3 centimetres in length at 0° C. be the specified column.

3. That standards in mercury or solid metal having the same resistance as this column be made and deposited as standards of resistance for industrial purposes.

4. That such standards be periodically compared with each other, and also that their values be redetermined at intervals in terms of a freshly set-up column of mercury.

It was further agreed that these resolutions be communicated to the Electrical Standards Committee of the Board of Trade.

With regard to the units of current and electromotive force it was agreed that the number ·001118 should be adopted as the number of grammes of silver deposited per second from a neutral solution of nitrate of silver by a current of 1 ampère, and the value 1·434 as the electromotive force in volts of a Clark cell at 15° C.

Dr. von Helmholtz expressed his full concurrence in these decisions, which are, as he informed the Committee, in accord with the recommendations which have already been laid by the Curatorium of the Reichsanstalt, as well as by himself before the German Government.

APPENDIX II.

Experiments on the Effects of the Heating produced in the Coils by the Currents used in Testing. By R. T. GLAZEBROOK.

Various circumstances (notably the experiments of Mr. Griffiths*) had made it appear probable that the heating effect in the coils produced by the current used in making the resistance test might be sufficient to affect the results of the tests. Some experiments were made to examine the point directly.

The resistance of a coil of 100 ohms (nominal value) was measured in the usual way, *i.e.*, by making a Wheatstone's bridge of four coils whose nominal values were 1, 10, 10, and 100 ohms. If the coils had been accurate there would have been a balance; as it was, one of the 10-ohm coils needed to be shunted, and the adjustment was made by determining the value of the shunt when no current passed through the galvanometer.

As the current in the battery circuit was increased by varying the number of cells this shunt decreased in value, showing that the effect of the heating was to produce an apparent diminution of the resistance of the 1,000-ohm coil. This, of course, is as would be anticipated; for $\frac{1}{11}$ths of the current goes through the 1-ohm and one of the 10-ohm coils; the remaining $\frac{1}{11}$th goes through the 10-ohm and the 100-ohm. The rise of temperature will clearly be greatest in the first 10-ohm coil, and to counterbalance the increase in resistance produced thereby it becomes necessary to reduce the shunt.

* *Phil. Trans.*, 1893.

The following readings were obtained:—

Current in ampères.	Shunt in 1,000 ohms.	Correcting factor.
·05	35·5	1 − ·00028
·09	32·5	·00031
·12	*30	·00033
·14	30·5	·00033
·15	29·5	00034

* Only one observation at this current was made; the others are the mean of several.

The true value of the 100-ohm is given by taking the product of the values of the two 10-ohm coils at the temperature of the observations, dividing by the value of the 1-ohm and multiplying by a factor representing the effect of the shunt.

During the above observations the temperatures remained steady, the factor changed from 1 − ·00028 to 1 − ·00034. Thus the resistance of the 100-ohm coil changed by ·034 − ·028, or ·006 ohm.

The apparatus was not sensitive with a smaller current; the effect, however, will vary as the square of the current; and, since trebling the current produces so small a change, we may infer that the total effect is itself small.

Another coil gave the following results:—

Current in ampères.	Shunt in 1,000 ohms.	Correcting factor.
·05	48	1 − ·000208
·09	45	·000222
·12	43	·000233
·14	41	·000244
·15	40	·000250

indicating a change in the measured resistance of ·0042 ohm on 100 ohms.

It is clear, therefore, that the effect of heating is small, though appreciable when currents approaching ·15 ampère are used.

ON STANDARDS OF LOW ELECTRICAL RESISTANCE.

By Prof. VIRIAMU JONES.

(*Read before Section A, Sept. 18th*, 1893.)

THE preparation of standards of low electrical resistance of from ·001 to ·0001 ohm seems to be a matter of some importance at the present time. These standards are already in request among engineers, and it becomes of interest to consider how they may be best measured to a percentage accuracy comparable with that with which the standard ohm is known.

Such standards of low resistance may be derived by potentiometer methods from the standard ohm by a series of downward steps. But this is, from one point of view, roundabout. The method of measuring the ohm that seems in all its details most accurate is that of Lorenz. In this method the ohm itself is derived from the measurement of a small resistance. It is simply going up and down again to prepare from the ohm so derived the required small resistance standards, and it is more direct and more accurate to measure the latter directly in absolute measure.

In Lorenz's method a metallic disc is made to rotate in the mean plane of a co-axial standard coil. Wires touching the centre and circumference of the disc are led to the ends of the resistance to be measured, and the same current is passed through this resistance and the standard coil. The connections being rightly made, we may, by varying either the rate of rotation of the disc or the resistance measured, so arrange matters as to have no change of current in the circuit of the disc and wires joining it to the ends of the resistance, when the direction of the current through the resistance and the standard coil is changed. When this arrangement is effected, there is a balance between the E.M.F. due to the motion of the disc in the magnetic field of the current in the standard coil and the difference of potential at the ends of the resistance, due to the current traversing it. If this adjustment be made, we will say that the apparatus is in an equilibrium position.

If M = coefficient of mutual induction of the standard coil and the circumference of the disc;
n = the rate of rotation of the disc (number of revolutions per second);
R = the resistance;
γ = the current through the standard coil and the resistance;
then in an equilibrium position

$$M n \gamma = R \gamma, \text{ or, } R = M n.^*$$

I do not think that electricians have as yet realised the accuracy and ease with which absolute measurements of resistance may be made by this method.

First let us consider accuracy. The absolute measurements involve measuring; first, the coefficient of mutual induction of a standard coil and the circumference of the rotating disc; and secondly, the rate of motion of the disc. Now it lies well within the resources of modern mechanical engineering to make a standard coil and disc of dimensions known to an accuracy considerably greater than 1 in 10,000, the coil being constructed of a single layer of wire, wound in a screw thread cut in a cylinder of large diameter, and the measurement of the rate of motion to equal accuracy is a simple matter. There is difficulty in maintaining a rate of rotation constant to this figure for four or five minutes; but with the closest attention to the lubrication of all the bearings, this also might be accomplished. Such constancy is well worth striving for, as the ease with which measurements of resistance can be made by the method largely depends upon it, and this brings me to the second point I mentioned, viz., the facility with which accurate measurements may be made with a well-constructed Lorenz apparatus.

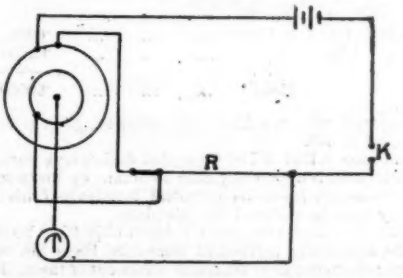
* *Phil. Trans.*, 1891, Ap. 2.

I do not propose on this occasion to enter into the details of the method I have adopted in making the measurements, the results of which I have presently to bring before the section; but it will be perhaps of interest if I say a word or two about the time measurement.

In measuring a resistance, we have to find the rate of rotation corresponding to an equilibrium position. It is easiest in practice to determine this by interpolation from two determined rates of rotation (near together, and respectively slower and faster than the required rate), and the galvanometer deflections corresponding to them, so that each determination of resistance involves no determination of galvanometer deflection and of the rates of rotation corresponding to them.

In order that the galvanometer deflection may be obtained with sufficient accuracy from a limited number of reversals (in my observations the number has been almost uniformly 33, taking about four minutes in each case), the brush at the circumference of the disc needs to be perforated, and to be supplied with a constant stream of mercury. Such a brush in its best condition almost entirely eliminates the continual jerking of the galvanometer needle, consequent on thermo-electric changes at the point of contact of brush and disc. A multiplication of such brushes, at three or four points of the circumference, would do this more completely.

During the four or five minutes' run, the rate of rotation is referred by a stroboscopic method to a suitable tuning fork provided with riders maintained in vibration electrically. The observer at the fork can shunt more or less current through the electro-motor driving the disc, and in this way maintains the rate of rotation as constant as he can. But though the electrically maintained fork is useful for purposes of control, it cannot be relied on to give us the rate of rotation. Its



vibration period is not, within my experience, constant to the degree of accuracy required. If stopped and set going again it may start with a period difference by several ten thousandths. No previous determination of the period of the fork could, therefore, be relied on to give us the rate of rotation, though once started the fork goes sufficiently uniformly to give us a means of control.

Accordingly it is necessary to measure the rate of rotation during each run while the galvanometer observations are being made. The rotating disc is, therefore, by means of an eccentric attached to its axle, made to record its revolution on the tape of a Bains electro-chemical telegraph instrument side by side with the record of the standard clock. We have then a time record exactly corresponding to the period of observations of the galvanometer deflecting. During the run, then, we have simultaneously the observer at the galvanometer calling out the galvanometer deflections, and the observer at the tuning fork controlling the speed, while the Bains instrument records it.

I have made in this way a number of measurements during the months of July and August of a standard resistance approximately ·0005 ohms, prepared last year by my assistant, Mr. Harrison, and a student in my laboratory, Mr. Parker, with the following results:—

July 17th, morning	... ...	·00050016
„ „ afternoon	... ...	·00050016
„ 19th, morning	... ...	·00050015
Aug. 2nd, afternoon	... ...	·00050020
„ 3rd, morning	... ...	·00050021
„ 4th, morning	... ...	·00050016
„ „ afternoon	... ...	·00050013
„ 5th, morning	... ...	·00050019
„ 9th, morning	... ...	·00050021
„ „ afternoon	... ...	·00050018
		·175
Mean	... ...	·00050017

that maximum divergence from the mean is ·00000004 in about 1 part in 12,000.

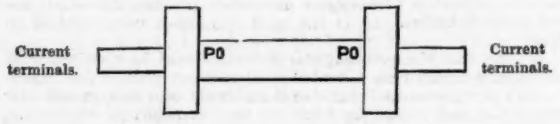
Mr. Crompton has been recently issuing standards of low resistance made of manganin sheet, and he was kind enough, at my suggestion, to send me one for measurement towards the end of July. It was prepared in his laboratory as a derivation from the International ohm by means of his potentiometer. Its value so given was ·00050175 at 23° C. Its temperature coefficient appears, from Mr. Crompton's, measurements to be so small that we need hardly consider it for our present purpose.

My measurement of this standard was as follows:—

July 29th, morning	·00050219
August 1st, morning	·00050225
August 1st, afternoon	·00050219
„ 2nd, morning	·00050226
Mean	4189 ·00050222
Mr. Crompton's value	·00050175
Difference	47

is about 1 part in 1,000.

Mr. Crompton's resistance is a rectangular sheet of manganin, and the potential terminals are two screws inserted at a suitable distance apart in the medium line.



The screws are not soldered. I thought it would be of interest to measure them; then screw them up again and remeasure the resistance The results were:—

August 10th, morning	·00050328
„ afternoon	·00050322
	·00050327
Mean	·00050326

a variation of about 1 part in 500.

I measured them again, and, after screwing them, once more remeasured with the following results:—

August 11th, morning	·00050398
„ 12th „	·00050403
Mean	·00050401

which, compared with the first value ·0005022, gives a variation of roughly 1 part in 300.

The conclusion is that if Mr. Crompton desires an accuracy of $\frac{1}{10}$th per cent. which he is apparently able to obtain by his potentiometer method, he must not leave his potential terminals of his resistance loose. They must be soldered into his plate.

In making these measurements my direct object has been to obtain an accurate and ready method of measuring these low resistances. But I think something more than this comes out of them. It would be possible in the light of our present experience to construct a Lorenz apparatus considerably more accurate and easier to use than one in my laboratory at Cardiff. Such an apparatus placed in the National Laboratory, of which we have heard a good deal at recent meetings of the B.A., might with advantage be kept in constant use, not only for the calibration of low resistances, but also as embodying in concrete form a proper ultimate standard of electrical resistance. We have not in our electrical standard legislation given full credit to the mechanical engineer for what he can do for us; and I think that a coefficient of mutual induction arranged as in the Lorenz method, so as to be easily combined with a time, would afford a more satisfactory ultimate standard of resistance than any wire coil or coils, and one easier to use for purposes of ultimate reference than any mercury columns.

DISPOSAL OF REFUSE.

FROM a valuable paper on "Disposal of Refuse" just read before the British Association at Nottingham, by Mr. Wm. Warner, Assoc.M.Inst.C.E., we take the following quotation, which deals with the question of refuse disposal in connection with electric lighting:—

"The horse-power given at Batley is 5; at Blackburn, 5·6; Bury, 4; Bradford and Leeds, about 4 per cell, which is equal to about 4·5 horse-power generated from 5 cwts. of refuse, or about 125 lbs. per horse-power, and 6·25 lbs. to 1 lb. of water evaporated, giving a comparison of about $\frac{1}{4}$nd the value of coal when burnt in Fryer's destructor at the above towns.

"The horse-power at Hornsey is about the same in the 'Perfectus' destructor.

"At Oldham the horse-power is given at 50 for 6 cells, equal to 8·3 per cell, or about 46 lbs. of refuse per horse-power, and 2·3 lbs. to 1 lb. of water.

"It is, however, difficult to reconcile these figures, as practically the same furnaces, with equal steam generating appliances, give less than half that power at Leeds and Bradford.

"It will be seen from these figures we cannot look forward to a large amount of power for electric lighting, and it is even questionable whether the power generated could be usefully adopted for that purpose.

"Take a town like Nottingham, and suppose its refuse to have the average steam producing qualities, we should get about 300 horse-power for an expenditure in labour of nearly £17 per day, equal to over £5,000 per annum.

"With coal, the cost for labour would be only £150 per annum, and the cost of coal for fuel would be under £1,500; therefore, taking the refuse to cost nothing for delivery at a destructor works conveniently situated for producing electricity, the actual loss would amount to no less than £3,350 per annum over coal fuel, and if we take into consideration the cost for repairs, and interest on capital, this loss would be greatly increased.

"Looking these facts in the face, electric light produced by burning refuse can only show economical results in very exceptional cases, and authorities should well weigh the matter over before launching into a scheme of that kind."

From the inventor of a special form of destructor (in use at Hornsey, Bournemouth, Newcastle-on-Tyne, Govan, Royton, Cardiff, Hyde, Kensington, City of York, St. Luke's, Karachi (India), London), the frank avowal of the concluding paragraph is worthy of the closest attention.

ELECTRICAL ENGINEERING AT THE WORLD'S FAIR.

[FROM OUR SPECIAL COMMISSIONER.]

XIII.—ARC LAMPS.

THE display of arc lighting is enormous. No branch of electrical engineering has made more progress, commercially, than arc lighting in America, and hence it was to be expected that there would be a great display at the World's Fair.

The grounds are lighted by 1,421 arc lamps, and at the terminal stations there are 160 6-ampère lamps and 228 3-ampère lamps; in the buildings there are 3,426 arc lamps of various candle powers.

Arc lamps are exhibited by several firms; but most of them are well known lamps, which have been described over and over again.

The Byng arc lamp, exhibited by the General Electric Company of London, somewhat resembles the Pilsen lamp, but has not the tapered cores which form the special features in the Pilsen electro-magnetic regulator. The cores in the Byng lamp are parallel and carry coils of wire. It can be

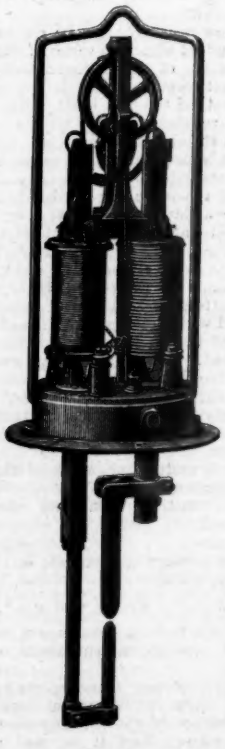


FIG. 1.

made for parallel or series working and also for alternating currents.

Schückert & Co. exhibit the Pilsen lamp, so well known in

London; the construction is on the same lines of design as the original lamps, but the arrangement of the parts is very much better than in the early lamps.

Fig. 1 is an elevation of the Schückert form of Pilsen lamp. It will be seen that the whole of the regulator is planted on the bottom plate of the lamp, the two bobbins are stiff brass, turned up true, and faced so that they stand fair, and are firmly screwed down to short pillars, the cores are guided by slots and pulleys; these are great mechanical improvements. In the old lamp, part of the movement was fixed to the top plate and part to the bottom plate, both plates were joined by four brass rods; these rods acted as guides for the cores, also as supports for the coils, and also as part of the framework. This construction was bad, so much depended upon the rods being straight and true to begin with and remaining so in use, almost impossible conditions to fulfil in practice. An examination of fig. 1 will show that the whole mechanism now forms one rigid piece, is easy to put down fair, square, and true, and which will then remain so.

Electrically, the Pilsen lamp is shown without any improvements; they require considerable resistance in series with them when run in parallel, and are suitable only for continuous currents, but being made by special tools and machinery are very cheap.

The Siemens & Halske Company show their band arc lamp. The upper carbon holder hangs from a thin copper band; this band is coiled upon a barrel having teeth cut on a flange on one side, so that it gears into a train of clockwork with an escapement. The construction of the band arc lamp is based on the following principle:—An inclined frame turns on pins, *e*, and supports a drum, *b*, around which a copper band is wound. This frame also supports the pinion wheels with the escapement, and at the upper end of the

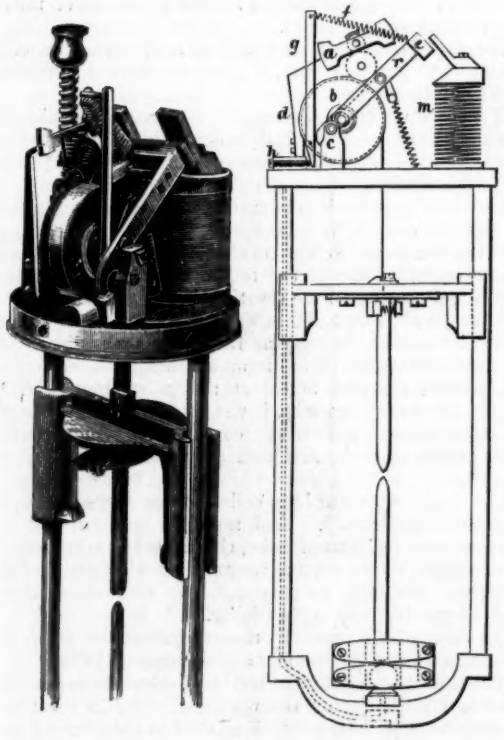


FIG. 2.

frame a cross-piece, *e*, which is the iron armature. The attraction of a shunt electro-magnet, *m*, and the weight of the upper carbon and holder, draw the frame, *r*, downward, while a spring, *f*, pulls in the opposite direction. The unwinding of the copper band causes the drum, *b*, and the pinion wheels to revolve, while the escapement with its balance lever, *a*, oscillates rapidly. When the frame, *r*, is in its highest position, a tongue piece projecting from the balance lever, *a*, strikes a stop, *g*, and the motion of the clockwork ceases. By turning the frame downward, the copper band, which carries the upper carbon holder, is gradually unwound from the drum, while the upper carbon holder sinks slowly by its gravity.

The lamp operates as follows:—When the current is turned on, the frame is turned downward by the strong attraction of the shunt electro-magnet into its lowest position, and the copper band unwound until the upper carbon touches the lower one. The current will then flow through the carbons instead of through the shunt, and the electro-magnet therefore loses its currents. The spring, having an excess of power, draws the frame up again and forms the arc between the carbons. If the carbons are consumed the current in the shunt magnet is increased gradually and the frame is drawn downward again and the arc is brought to its proper distance. The slightest change in the length of the arc will start the escapement, and this will cause the lamp to feed in regular intervals of time. The light is therefore very constant and the arc is practically constant.

Other lamps are exhibited, but they have no interesting features. The dash-pot is a great feature in American lamps; it is principally on the air pump principle, although the glycerine dash-pot is still used by some.

Schückert & Co. show the largest arc light projector ever built, it is 5 feet in diameter. We have referred to this more than once in the ELECTRICAL REVIEW.

In incandescent lighting there are altogether about 70,000 lamps of 16 C.P. used. High candle-power incandescent lamps are not in much favour in America. For ordinary lighting 40 square feet of floor space is allowed to each incandescent lamp of 16 C.P. For brilliant lighting, such as is used in the Art Gallery, about 20 square feet is allowed for every 16 C.P. lamp, and in the small rooms of the gallery about 8 square feet to each 16 C P. lamp.

CORRESPONDENCE.

The Use of Incandescent Lamps of Low Power.

With reference to your leaderette on "Incandescent Lamps of Low Power," perhaps the appended letter may interest you, as proof of the correctness of your views. The gas bill on which the £8 was gained amounted to about £40 for the quarter in question.

Miller & Woods.

September 23rd, 1893.

"The cost of supply for quarter ending March last was nearly £8 less than the gas bill for the corresponding quarter of 1892. Many of our friends complain of the cost of supply. This would have been the case with us had we allowed all 16 C.P. lamps to remain in use. We found these lights too powerful, and wasted a large amount of light, and we replaced them with 8 C.P., with the satisfactory result that our cost of supply was one-half, and sufficient light was obtained. We have every light separately switched, which we consider essential to economy, and we never allow lamps to burn to waste; and the result is we are perfectly satisfied with the light itself, and the cost of producing the same."

HENRY WILLIAMS & Co.

Messrs. Miller & Woods.

Electrical Engineering at the World's Fair.

Referring to "Your Commissioner's" letter in your issue of September 1st, I would point out that he seems to have overlooked the gist of my letter of August 22nd. My point is this, that the $W P_{30}$ motor, which is a single reduction iron-clad motor exhibited at Chicago, has "the ratio of the cross-section of the field, to the cross-section of the armature = 1·62 : 1." "Your Commissioner," in your issue of August 4th, states that this motor, with others, is designed "with a very large armature and weak field."

It is this statement to which I took exception, and wrote about, as "somewhat sweeping." Still, confining myself to the designs of the General Electric Company, I give particulars of two other types of railway motor, which, I see, from the New York *Electrical Engineer* of July 19th, are also on exhibit at Chicago. The $W P_{50}$ type of railway motor is similar to the 30; the same ratio of cross-section of iron in field, to iron in the armature, holds good as in the 30-type; the other type, known as the "S. R. G.," has a cross-section of iron in the field of 66 square inches, and in the armature core of 49·2 square inches; the ratio of field of armature, in this case, being = 1·34 : 1. These three

types are fairly representative. With regard to the Westinghouse motors I understand, from an electrical paper, that the fields are of cast-iron and not of cast-steel, mitis metal, or wrought-iron, as are the three types mentioned above.

As I said, in a recent article, a "railway motor field is always saturated," and this may be seen by reference to curves, p. 571, of the ELECTRICAL REVIEW, May 12th, 1893. However, I do not admit that the fields of the motors must be "far over magnetic saturation at the start." If the fields were not saturated when running at ordinary speed, this would be, as "Your Commissioner" says, "perhaps a worse fault than the over-saturation at the start."

I would add that, in the stationary motors of the above-named company, the ratio of the cross-section of the magnets, to the cross-section of the armature, is about unity in *one* case, and in the *thirteen* other cases *less* than unity; and, in the case of the railway motors, *greater* than unity. Surely these figures rather contradict (at all events in the case of one company) "that *all* these railway motors are designed with very large armatures and *weak* fields."

I enclose, for the perusal of "Your Commissioner," the magnetic data on some upright stationary motors; these data I am not in a position to publish.

J. D. Dallas.

Mr. Dallas altogether misses my point. What I contend for is simply this: that armatures of large diameter and length, compared with the weight or dimensions of the field magnets, were generally made for traction purposes in America; a magnet has length and other dimensions besides sectional area, and so has an armature. The sectional areas may be right enough in these motors, and still the other dimensions may be all wrong. The data enclosed refers to stationary motors only, and not to those under discussion. Mr. Dallas might sketch an outline section to scale of one of the traction motors.

Your Commissioner.

Arc Lighting.

If the writer of the series of papers on "Arc Lighting," published in your esteemed Journal, will visit the World's Fair at Chicago, I shall take pleasure in showing him, not one, but several dynamos, by different makers, for constant current arc lighting, with closed coil armatures, giving a maximum of from 2,000 to 5,000 volts. In the light of American practice his assertion in the ELECTRICAL REVIEW for August 25th, that "beyond about 1,000 volts, it is found, in general, to be impracticable to work a closed coil armature" is ridiculous. I can show him many dynamos, running from 50 to 100 arc lamps, with closed coil Gramme ring armatures, and with the commutators smooth and almost absolutely sparkless. Even 5,000 volts is not the limit in actual practical use. With all due deference to my friend Prof. Silvanus Thompson, from whom the writer referred to quotes, it would nevertheless be wiser to refer to American experience as to what can or cannot be done with arc lighting dynamos, since here series arc lighting has had its chief development and most extensive application.

Henry S. Carhart.

University of Michigan, Ann Arbor.

The New Incandescent Arc Lamp.

In reply to Mr. Rankin Kennedy's letter, I would say the following: In the experiments I conducted, I tried two carbons of the ordinary arc lamp in a tubular globe of glass, as well as the Jablochkoff candle; and, besides this, many other experiments for using an arc light in closed spaces, such as metal reflectors with glass fronts, &c. The chief difficulty I had to contend with was that of keeping draughts away from the heated glass, and I found that when protective glasses had to be used outside the effective one, considerable loss of light ensued. I therefore had recourse to another method of obtaining a similar result, which has many advantages, and I often wonder why it is not more used. It is that of surrounding the incandescent ends of the carbon with a flame from an argand burner, supplied with gas from the ordinary source, or from a mineral oil. All the advantages which are to be derived from the use of the enclosed glass are present. Great steadiness of the arc is obtained with lamps of the worst construction, and with carbons of inferior quality. Besides this, the intense whiteness, or blueish-whiteness, so peculiar to the arc, is modified in an agreeable way; while, if this result is not desired, it is only necessary to construct the argand on the Bunsen principle. The difficulty, also, of working the carbons through the glass bulb is absent. By difficulty, I do not mean the simple fact of passing the carbons through the glass; but if the former are not quite straight, or properly set in their holders, there is always risk of failure. I did not patent, as far as I can remember, the ring of heated gases around the arc in the manner described, and therefore anyone is at liberty to try the experiment for himself, and observe what good results may be obtained by this method.

David Salomons.

September 23rd, 1893.

Hooper's Core for Submarine Cables.

In your leader on "India-Rubber Insulation," I read:—"Much will be learned by a perusal of the article on 'Hooper's Core for Submarine Cables,' which we give elsewhere. That India-rubber can be depended upon is, we think, amply proved by the facts there set forth. It hardly requires to be said that a guarantee to maintain a cable with an India-rubber core for a period of 12 years was a risk which no manufacturer would undertake were he not absolutely certain that the material could be relied upon for durability." I find the article referred to occupies three and a-half columns of type and a page of illustrations. In the whole of this long article there are only 10 words devoted to that remarkable fall in insulation which took place while the cable in question lay in the tanks at Millwall, and in the tanks on board the ss. *Hooper*; and which fall was the real cause of what the author of that article has been pleased to describe as "aspersions cast on the good qualities of the late Mr. William Hooper's core."

The writer concludes his article with an expression of his opinion that Hooper's core is likely to prove a formidable rival to gutta-percha.

If such be his desire, it seems to me that he would have promoted his cause better had he devoted his three and a-half columns to the discussion of the core-faults, and his 10 words to the fish-attacks.

The facts narrated by the author of the article in question are accurate enough for practical purposes, so far as they go; and this forces me to the conclusion that the writer must have been fully aware of the following circumstances, which have a real bearing on the question of rubber insulation:—

A length of about 1,000 miles of Hooper's No. 1 core was made and sheathed in the year 1872. In the spring of 1873 the insulation began to fall in an alarming manner, and this fall progressed to such an extent that when the ss. *Hooper* arrived alongside the works, it was considered unsafe to ship it; other cable of more recent construction was substituted for it during both the first and second expeditions of that ship.

The faulty cable had been coiled in the large tanks, Nos. 3, 4 and 6, at Millwall. Each tank had been cut into three sections, viz., the bottom flake, the next 10 flakes, and the main length, with a view to ascertaining whether the fall of insulation was local or general. The tests of these nine sections proved to be fairly similar.

No attempt was made by the contractors to break down the faults during the summer and autumn of 1873.

The insulation went from bad to worse. I do not know what took place during the winter of 1873-74; but I remember to have been much astonished to learn, on my return from the second expedition of the *Hooper*, that all the faults had been removed from the greater part of the cable in the "hospital" tanks, and that this was to be shipped on the third expedition.

I believe I was on leave during the greater part of the shipment, for I only remember to have tested one length at that time, and this length proved to be faulty.

During the outward voyage the contractors' electricians were kept constantly employed breaking down faults, and a total amount of 1,111 nautical miles had been turned over on board for this purpose after shipment had been completed, and before laying was commenced.

These are facts which it is futile to attempt to burke, and

I think I am rendering true service to rubber by frankly facing them.

The feature in the history of Hooper's core which most impressed me was that, while some lots of core went wrong, other lots behaved admirably.

In his 10 words about the fall in insulation the author of the article on "Hooper's Core" has alluded to the free use of tar. I fail to see how tar could have caused any one of the core faults which came under my observation.

I purposely abstain from making any suggestion here as to how these faults were caused, and the following remarks are intended to refer to core in general, and not to that of any particular maker.

Hitherto it has been the custom of the trade to surround the manufacture of core with as much secrecy and mystery as possible.

In earlier days this practice was not so objectionable, from the purchaser's point of view, as it has become now. Gutta was the only material then used, and gutta of excellent quality was easily obtainable.

But the temptation to substitute cheap, and inferior, qualities, becomes stronger in proportion as the scarcity of the good qualities and the competition between manufacturers increases.

The rubber manufacturer is exposed to the same temptations as the gutta manufacturer, and to an additional one.

Foreign substances necessarily enter into the composition of rubber core, and each of these ingredients is, weight for weight, far cheaper than rubber. Moreover, the manufacture of rubber core is more complex than that of gutta core. There is more danger of core being spoiled by unskilfulness or carelessness in the case of rubber than in the case of gutta. More time needs to be spent over rubber than gutta, and in the event of a rubber core factory getting behindhand, there is the danger that, if the foreman were not perfectly conscientious, he might prefer to scamp more than one of the stages through which the rubber has to pass, rather than incur censure for keeping the cable machines standing.

In my opinion, an advocate of rubber only weakens his cause by attempting to deny that good rubber is exposed to disadvantages upon all these points when compared with good gutta.

But each of these disadvantages can be guarded against; and if this be done the case seems destined to be decided upon the question of price.

I think the opinion which you express at the conclusion of your leading article needs to be qualified by the condition that the examination of raw materials and of every stage of manufacture needs to be open to the inspection of an independent expert acting primarily in the interest of the purchaser, and indirectly in that of the manufacturers.

No one can congratulate Mr. Hooper, the Cuba Company and Mr. George Keith on the success of the so-called experiment more than I do; but I do not see that it has proved much, for it has long been known that a cable containing high resistance faults can be worked *in simplex* rather better than a perfect one.

The fact that the Silvertown Company have recently laid a rubber core between Pernambuco and Fernando Noronha, to be worked *in duplex*, has a greater bearing on the question of India-rubber insulation.

The story of the fish-attacks, though it has little to do with the discredit into which rubber fell 20 years ago (for obviously the core could not be held to blame for the faults of the sheathing), is an interesting one to cable engineers in general, and it had a particular interest for me, inasmuch as I had to lay a cable in the selfsame waters in 1890-1891.

From the text of the article on "Hooper's Core for Submarine Cables," one might be lead to infer that the fish-attacks were inflicted upon cable of Atlantic type, and containing the Atlantic core, which the author seems to consider to have been *mechanically* faulty, though I am at a loss to conjecture upon what grounds he arrived at that conclusion. As I witnessed all the repairs effected on the original Para-Cayenne-Demerara cable, I can speak with some authority upon this matter. The great majority of the faults which we attributed to fish-attacks occurred in a cable of type H, which was constructed expressly for the place in which it was laid. It consisted of a core, No. 3 (107/170), close sheathed with No. 13 wires.

This is the type of cable which is shown in each of the illustrations given on page 327 of the ELECTRICAL REVIEW.

This core had been made after the fall in insulation had occurred in core No. 1, and it always tested excellently. It was a curious and very useful circumstance that the attacks were mostly delivered in the neighbourhood of the splice with the heavier type, B, and the faults were always on the H side.

This spot had to be revisited so often, that we ended by leaving a buoy permanently down, instead of clearing the ground on the completion of the repair. Whales were frequently observed at this spot. I do not attribute any of the faults to the whales themselves, but I believe the sword-fish, which is known to attack the whale, also had a shot at the cable. There was one case in which a large portion of what I consider to be the point of a sword was observed sticking right through the sheathing. It happened to have glanced clear of the copper, and so did not constitute an electrical fault.

Other faults were attributed to saw-fish by general consent, though I believe that no one on board was aware that Mr. Frank Buckland had suggested that a fault in the Penang-Singapore cable was due to the same cause. I noted the fact that these fish seemed to succeed in damaging the core only when they struck fair in the interstice between two wires; and the fact that the B type close at hand never went faulty, seemed to prove that the wires of that type (No. 5) were too rigid to yield under attack.

For the cables which now connect Paramaribo with Cayenne and Vizeu, I specified wire of 4·5 mm. diameter.

The section between Vizeu and Cayenne (S.W.G. No. 7) passes right through the whale ground above referred to, and is laid throughout its length in water of less than 50 fathoms. The most recent test of which I have cognisance was taken 20 months after completion, and showed an insulation resistance sensibly the same as when the cable was laid, which was over 2,000 megohms per nautical mile, when reduced to a temperature of 75° F.

Whilst writing on this subject, I should have liked to refer to the interruptions that have occurred in these cables; but as this matter is not yet one of comparatively ancient history, I do not feel at liberty to do so, except with the approbation of the owners, to whom I am now writing on the subject.

W. Sharpey Seaton.

57½, Old Broad Street,
September 27th, 1893.

NOTES.

Appeal for Help.—We have pleasure in thanking those kind friends who have generously responded to our appeal published last week; we trust, however, there are yet some who have not seen the notice, but who may be able to afford the late Mr. Berly's relatives some little assistance.

The Receipts of the Edison Company at Paris.—It has been said over and over again, and has most probably been set about by the Paris Gas Company, that electrical companies could not succeed, and would not do any business. But it has been with them as with all enterprises. During the first few years it has been difficult to complete the installations, then little by little everything has been installed and has worked well; the price of the hectowatt-hour has been reduced, and consumers now complain only of the expenses charged by companies for indoor installations. There is no doubt, in fact, that these latter try to deceive clients, and make them pay exorbitant prices for work which is very often accomplished without any extra precaution, and without any guarantee. Notwithstanding all these difficulties—and efforts are every day being made to overcome them—the expenses of the consumption of electrical energy increase, if we are to believe the figures given by the Edison Company, the only one which has furnished us with statistics. During the month of July, 1893, the sale of energy for the Edison Company amounted to 132,538 francs, an increase of 1,392 francs over the year 1892. From January 1st to July 31st, 1893, the increase in the sale of energy has amounted to 116,681 francs over the year 1892.

The Moment of Reversal in the Quadruplex Relay.—Referring to this subject, Mr. D. B. Grandy, in an article in the American *Electrical Engineer*, says :—A study of the diagram fails to show how it should do this, even theoretically, and a trial of the device gave, as I expected, a decidedly unsatisfactory result. There are three distinct periods in the process of reversal in the polarity of a magnet: 1st. The discharge ; 2nd. The period of no magnetism ; and 3rd. The recharge by the other current. In a polar relay, the armature does not leave one side until the first two of these periods are passed, and the third has proceeded far enough to at least partially magnetise the cores. In a "neutral" relay, on the contrary, the armature leaves its front stop as soon as, or a little before, the first period is completed. Referring, now, to the diagram of Wicks's arrangement (ELECTRICAL REVIEW, September 8th, page 26), it will be noted that on reversal of current from the distant end, relays P, R, and N, R, will discharge simultaneously, and the armature of N, R, will fall away before N, R, is entirely discharged, remaining away during the second, or neutral period. During the third period, by the time P, R, attains sufficient magnetism of the other polarity to attract its armature, N, R, will also have been partially magnetised by the same current ; but at that moment the circuit through N, R, is broken by the armature of P, R, leaving its contact point, N, R, again discharges, and on the armature of P, R, reaching the other point, N, R, is recharged with the same polarity it originally possessed. Thus, instead of shortening or avoiding the neutral period, Mr. Wicks's device practically lengthens it by introducing two changes of polarity instead of one. With a neutral relay having very large cores this defect is not so pronounced, and may be overcome by the repeating sounder, but with those of ordinary size the break is very noticeable.

Progress Exhibition at the Palais de l'Industrie, Paris.—In the Exhibition that has been held at the Palais de l'Industrie since July, a special class has been reserved for electricity. Unfortunately all the installations are not yet in working order ; we will, however, mention those we have been able to inspect up to the present. A distribution of electrical energy has been effected in the large hall of the Palais de l'Industrie, and the exhibitors are able to procure what electrical energy they require. This energy is supplied by a main taken from the system of the sector of the Champs Elysées, by means of transformers at 3,000 volts. The firm of Cail are just completing a small installation, which will be very interesting ; we have seen as yet continuous current dynamos worked by small steam engines, an alternator of the Helmer type, and a few models of transformers with variable magnetic resistance. We shall have occasion to refer more fully to this subject when the installation is quite completed and at work, and in the meantime, will merely remark that Messrs. Cail's installation will offer an interesting subject for study, and at the same time be useful for purposes of demonstration. Messrs. A. Piot show a belt guide on a new model, and to effect transmission, they use an alternating current motor. Messrs. Ch. Brizal, of Charleville, show a model of a semi-fixed steam engine, supplied by a multitubular steam generator. The model exhibited is capable of working directly a dynamo giving four effective kilowatts. The firm constructs other types up to 200 H.P. In these motors the speed does not exceed 300 revolutions per minute for low powers, and 275 for higher powers. We also find a Willans steam engine working a dynamo direct ; these machines are already well known. Messrs. Patin have installed a vertical boiler and a vertical engine, working a dynamo of 50 kilowatts by means of a fly-wheel ; we find, also, some models of transformers. M. Heilmann will shortly exhibit some Brown motors. Messrs. Genteur show an electrical ballot-box, which seemed rather ingenious, but very complicated. Messrs. Plicque & Blanche show some models of apparatus for indoor installations ; we also examined some models of dynamos, and various gas and petroleum motors. Amongst the exhibits of this firm was the new simplified Brillié meter (see ELECTRICAL REVIEW for last week). As will be seen, we have as yet nothing particular to discuss ; but the various installations are now being completed, and we hope shortly to see some interesting applications.

Huddersfield Electric Lighting.—St. George's Square is to be lighted by arc lamps. There are to be three lamps erected at present, the cost being £45. It is stated that if the experiment is successful, the light will probably be used for the other public thoroughfares.

Killarney and Electric Lighting.—In August the Board of Governors, after very full discussion, approved the introduction of electric lighting into the Lunatic Asylum. The Board of Control on the matter going up for their confirmation, considered the proposal, and decided that they were not at present prepared or advised to sanction the scheme. Again the Governors have discussed the matter, with the result that they have resolved to ask the Board of Control on what grounds they refuse their sanction.

Mattei's Liquid Electricities.—A correspondent writes : "You may be interested in perusing, and possibly care to comment upon, the accompanying communications, which emanate from the London depôt of the Mattei Electricity Remedies. They owe their existence to the following circumstances :—Miss —— is a lady with whom I am acquainted, who is a firm believer in the remedies in question, and uses them. I have frequently laughed at the system before her, more especially protesting that the word electricity should not be used in connection with medicines in the form of liquids and pilules. I further mentioned that I had read a leaderette or letter in the ELECTRICAL REVIEW some time ago (when you published two or three articles on the subject), in which it was definitely admitted that the medicines had nothing to do with electricity, but that they were so called because of the rapidity of their action in effecting cures. Accordingly, in one of her letters to the central depôt, Miss —— mentioned what I had told her, and in reply received a letter, of which the enclosed is an extract. I then intimated a wish to forward the extract—which I cannot but regard as pure and unalloyed nonsense—for *your* perusal, and a request to this effect has resulted in permission so to do. The question of the efficacy of the remedies is not here at issue, but only the misuse of the term applied to that form of energy called electricity, and of words used in connection with it. In what manner, one feels inclined to enquire, does this liquid, styled negative red electricity, 'partake' of this particular form of energy? Does one of the imponderable fluids, imagined to exist by electricians many years ago, surround the liquid, or does it exist in a dissolved condition, or what is the connection between the two? Mr. Gliddon is evidently prepared to defend the case with proofs obtained by recent advances in electrical science, and it would be interesting, and perhaps amusing, to learn his views on the subject. I do not want to take part in a public discussion of this matter, because it is not the least in my line, and I do not, therefore, feel competent to do so ; but I should much like to see it handled by others. In the absence of the promised proofs, it seems to me that if Harness is guilty of misapplying terms, Count Mattei is far more so."

With reference to the Electricities. You are mistaken in supposing that Count Mattei says the liquids do not partake of electricity at all. In his last work he distinctly affirms that they do, and insists very strongly on the importance of observing the laws of polarity. The outer side of the limbs and fingers are positive ; the inner side negative. The right side of the head and trunk negative, and the left side positive. This may explain the fact that you found Red Elect. relieve the pain in your left thumb which is on the inside of the limb. There are exceptions to the rule, as you will see if you study the articles now appearing in *Modern Medicine* on the polarity of the body.

Yours faithfully,
A. J. L. GLIDDON, A.H.

[ENCLOSURE.]

Count Mattei's Remedies,
18, Pall East, London,
September 15th, 1893.

Miss ——

Dear Madam,—I am much obliged to you for your letter. You are perfectly at liberty to let your friend send the extract from the letter to the ELECTRICAL REVIEW. I shall have an opportunity of proving to him that he does not know as much as he thinks he knows about recent advances in electrical science, and of laying before other students some of the evidence which induced the eminent Parisian scientists, to whom Count Mattei is indebted for his knowledge of the subject, to formulate their theories.

Yours faithfully,
A. J. L. GLIDDON, A.H.

Lectures.—In connection with the Technical School of Cardiff, Prof. Viriamu Jones (Principal of the South Wales and Monmouthshire University College) on Friday night gave a lecture on "Electricity and Magnetism," at the Albany Road Board School.

Electrical Mishaps at Paris.—It is some time since any electrical mishaps occurred in Paris. On September 1st, however, at 11 o'clock at night, the Thomson-Houston arc lamps lighting the Boulevard de la Madeleine and the Place de l'Opéra suddenly went out in consequence of an accident to a machine at the Popp Company's station at Buen-Retiro. The same thing occurred on September 8th at about 8 o'clock in the evening. These accidents are much to be regretted; it is to be hoped that precautions will be taken to avoid them in future.

The Council of Hygiene and the Accumulator Factories in France.—The Council of Hygiene has recently been occupied with the discussion of accumulator factories, and the question has been raised as to whether these factories should not be classed amongst insalubrious and harmful buildings. We know that factories included in this class are subjected to severe restrictions and strict surveillance. The question was raised on account of certain accidents that had occurred in these factories. The proprietors of these establishments may consider themselves fortunate that the discussion of the subject has fallen into the hands of intelligent men like Messrs. Armand Gautier and Michel Lévy, who could see that they had to deal with a new industry, extending every day, and every day being subjected to fresh modifications. The processes employed were constantly undergoing changes and improvements. It was, therefore, impossible to include these establishments in the above category at present, without falling into grave errors. Therefore the accumulator factories in France are not classed amongst insalubrious buildings.

The New Installations of the Popp Company, Paris.—The Popp Company (Paris) is continually making fresh canalisations and fresh installations. At the beginning of September they laid mains at the beginning of the Boulevard Sebastopol and a corner of the Place du Châtelet and the Rue Saint Denis, at right angles to the Rue de Rivoli. Trenches have been opened, and in cast-iron pipes are laid insulated cables manufactured by the India-rubber Company, a few shovelfuls of sand being thrown upon them. The pipes were then covered in with cast-iron. In several other streets, particularly the Avenue de l'Opéra, the company has used Siemens's lead covered armoured cables, placed directly in the ground. Finally, the company is about to reduce considerably the number of accumulators that have been in service for some years. We know that up to the present the distribution has been effected in Paris by a series of sub-stations formed of accumulators. These sub-stations were all charged in series during the day from the central station on the Boulevard Richard Lenoir. Latterly the works at the Lake Saint-Fargean, which were formerly compressed air works, were turned into an electrical station supplying part of the system by charging the sub-stations of accumulators, and, if required, they could entirely replace the Boulevard Richard Lenoir station by means of a special line. A new and very important sub-station is at this moment in course of installation in the Rue Saint-Roch. The accumulators will be replaced by dynamo transformers, formed of two armatures mounted on the same axle; one serves as motor and the other as generator. These dynamos (Thury type) are to be constructed by the Société l'Industrie Electrique, for which purpose workshops will be erected in Paris. The station will comprise 18 transformers of about 30 kilowatts (100 volts and 300 ampères); five batteries will be left on the upper floors. This sub-station is now in course of installation; we shall have occasion to refer to it again. This partial substitution of transformers for accumulators is also being made at several important centres of distribution where the Popp Company had installed sub-stations. The changes are owing to the annoyances caused by the defective working and bad maintenance of the accumulators, which have not been in accordance with the clauses of the contract between the Popp Company and the Société des Metaux. The batteries are merely retained as a reserve.

Electric Lighting for Bow Infirmary.—The City of London Union have resolved to consider the desirability of laying on the electric light at the infirmary at Bow.

A Prosperous Career.—The will (dated March 13th, 1879) of Mr. Samuel Edmund Phillips, formerly of Victoria Works, Charlton, and late of Castle House, Shooter's Hill, Eltham, telegraph engineer, who died on July 22nd last, was proved on August 25th by Mrs. Emily Phillips, the widow and sole executrix, the value of the personal estate exceeding £87,000. The testator gives all his real and personal estate to his wife absolutely.

Telephonic Communication.—The Post Office authorities have decided to lay a cable from the Gunfleet Lighthouse to the Old Gapway, at Frinton, near Walton-on-the-Naze, as the first portion of the telephonic communication between the various lighthouses and vessels and the coast-guard stations at Harwich, Walton, and Clacton, all three of which will be connected by a land wire. The operation of laying the cable is now in progress.

Fulham Vestry and the Telephone.—At a meeting of the Vestry, a member proposed that the Vestry should get a telephone. He pointed out that they were spending at the rate of £40 per annum in telegrams to the Metropolitan Asylums Board alone, whereas they could be put on the telephone exchange for £20, and could communicate with all other bodies, tradesmen, and contractors. This proposition was referred to the Town Hall Committee for consideration.

Obituary.—Yet another name has to be added to the already lengthy list of pioneers of the world's telegraphic systems who have passed away within the last twelve months. Mr. Henry Weaver had long been connected with the great telegraph undertakings. He was generally to be seen at his seat on the board when the half-yearly and yearly gatherings of the companies with which he was connected were held, and though he was not a man of speech, his face will long be remembered by shareholders; his name has always carried with it a large connection with the business world, and has always been a surety of business capacity. His death happened very suddenly, and therefore unexpectedly at the end of last week, at Lowestoft, where he had been staying for the benefit of his health. He was born in May, 1825, and at the age of twenty-one entered the service of the Electric Telegraph Company, taking charge of various stations in England till 1853, when he was transferred to Holland upon the establishment of the International Telegraph Company. Returning to London in 1859, he became Metropolitan Superintendent for the Electric Telegraph Company, and manager of the International Telegraph Company in London, which position he occupied until 1864, when he was appointed secretary to the Electric and International Telegraph Company, holding that position until 1870, when the telegraphs were transferred by purchase to the British Government. The whole of the negotiations for the purchase by the State of the lines, cables, and business of the companies represented by Mr. Weaver were under his control, he being appointed sole arbitrator. After the transfer of the inland telegraphs to the State, he took the management of the Anglo-American Telegraph and the Atlantic Telegraph Companies, which positions he had held since the beginning of January, 1870. In addition to being managing director of the Anglo-American Company, the deceased was also a director of the Indo-European Telegraph Company, which company he assisted to bring out in 1869-70, in conjunction with Messrs. Siemens Brothers and the late Hon. Robert Grimston; a director of the West India and Panama Telegraph Company, the Western and Brazilian Telegraph Company, the Western Union Telegraph Company, New York, and the London Platino-Brazilian Telegraph Company. He originated the "word" system of counting and charging messages, and introduced it on the Atlantic cables in May, 1872. Mr. Weaver's desire that he should die while in harness has been fully realised, as he occupied the post of managing-director of the Anglo-American Telegraph Company until the day of his death. His position on the management of that company has been filled up by the appointment of Mr. Carson as manager.

Watford Electric Lighting.—The Local Board have appointed a committee to prepare the necessary notices with regard to the application for a provisional order.

Fulham Vestry and Electric Lighting.—The whole of the London local authorities are being circularised by the Fulham Vestry with questions as to whether the authorities supply the electric light themselves.

World's Fair Awards.—Among the list of awards that have been made in group 158 of the Liberal Arts Section appears the name of Mr. Henry Van der Weyde, who has secured an award for electric light photographs.

A New Lighthouse for Cornwall.—Mr. J. Passmore Edwards has made an offer to the Trinity Brethren to erect a lighthouse on the top of St. Agnes Beacon, Cornwall, to be supplied with the electric light.

The City Telephone Systems.—At a recent meeting of the Commission of Sewers, a letter was read from Mr. H. S. Foster, M.P., asking the Court to pass a resolution in favour of his obtaining a license from the Postmaster-General to establish a first-class double-wire telephone in the City at a maximum charge of £8 per annum. The letter was sent to the Streets Committee.

CONTRACTS OPEN AND CLOSED.

OPEN.

Kingston-upon-Thames.—October 7th. Tenders for an electric lighting installation for the Town Hall, public offices, library and courts. Full particulars will be found among our advertisements.

Lisbon.—October 5th. The Royal Portuguese Railway Company invite tenders for the installation of the electric light at Lisbon Station, and the tunnel of Rocio. Particulars can be obtained at Rue de Chatendum, 23, Paris.

Morley.—December 1st. The Morley Corporation are prepared to receive particulars of schemes for the lighting of the Town Hall and the borough generally. A premium of £100 will be awarded to the scheme selected by the council as the most suitable for the requirements of the borough. Plans and particulars to be sent before December 1st, 1893. Conditions of the competition may be obtained from the Town Clerk (R. Borrough Hopkins).

CLOSED.

Bristol.—Tenders for the electric light installation for St. Peter's Hospital were sent in, and there were eight applicants. The tender of Mr. Willway at £28 9s. 6d. has been accepted.

Huddersfield.—Twenty-four transformers for the Corporation, from the Electric Construction Corporation, cost £400. Full particulars are given regarding electric lighting of Huddersfield in our "Business Notices."

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's), now under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., is in active preparation for the 1894 edition (13th year). It will be considerably enlarged, while the price will remain as before, namely, 4s. It is indispensable to all having business transactions in the electrical world, and once used cannot be done without. Advertise in it! Order it! It will prove the best outlay ever made.

Electric Lighting of Derry.—The Corporation deserves great credit for the business-like manner in which the electric lighting has been promoted. The street lighting will be by arc lamps placed on pillars which are being erected throughout the city. The system adopted by Mr. Blake, the consulting engineer to the corporation, is continuous currents at high pressure worked direct from the generating station. There will be two circuits in each street and every alternate lamp will be placed on one of these circuits so that one half of them can be lighted or extinguished simultaneously. By a switch placed in the pillar each lamp can be extinguished separately. The city is divided into two sections (east and west), and each section has its own distinct and separate circuits. All the city south-east of Shipquay Street and Bishop Street, including the waterside, will be supplied from its own distinct duplicate circuits fed by two Siemens constant current dynamos, and all the city north-west of these streets will be supplied by different circuits from another pair of dynamos. A third or spare set of dynamos are in the station as a standby always ready to be switched on to any circuit in case of accident. These six dynamos are each capable of running 60 arc lamps of 2,000 candle-power each, but as two of the machines will be held in reserve there will be four in constant use, capable of running 240 efficiently. The present contract is for the installation of 160. The arc lamps are of the Brockie-Pell type. The conductors are highly insulated copper cables armoured and laid directly in the ground. This extensive system of street lighting by electricity is being carried out by the corporation without any additional tax on the ratepayers. It is estimated that the annual payment now made to the gas company for street lighting will cover the repayments and interest of the loan of £15,000 granted by the Board of Works, and we are informed that after the loan is paid off the cost of lighting the city by electricity will be only one-third of the cost of lighting it by gas. The corporation has been alive to the advisability of keeping the scheme in their own hands. Everything is in a forward state, the generating station has been erected, the boilers are set, the machinery is in course of erection and Messrs. Siemens Brothers and Co., Limited, are busily engaged laying the underground mains and wiring the lamp pillars, and by end of next month it is expected that two of the circuits will be lighted, and the other two circuits immediately after, so that all the installation will be completed and working this winter. We understand that the corporation is ready at any moment to undertake private lighting, provided a sufficient number of the ratepayers intimate their wish to be supplied.

Huddersfield Going Ahead.—At a recent meeting of the Council, the engineer brought under consideration the subject of the supply of electrical energy to mills and dwelling houses at Deighton, and submitted an estimate of the cost thereof and the income which would be derived therefrom. It was resolved that the engineer obtain further information and report thereon to a future meeting. It was further resolved that the electric supply main be extended along Manchester Street to the extent of 150 yards, in order to supply energy to Messrs. Lockwood and Keighley's premises; that an additional primary main be laid from the electric supply station to the Market Place transformer station, at an estimated cost of £500; that the engineer be authorised to purchase 6 18-kilowatt transformers for the Town Hall and the sub-stations, at an estimated cost of £56 each; and that the following transformers be obtained from the Electric Construction Corporation, Limited, viz.: 9 1,500, 9 3,000, 6 6,000, at an estimated cost of £400; that 18 switchboards for transformer stations be obtained, at a cost of £7 5s. 6d. each. The engineer reported that an order had been received from the Board of Trade, dated August 5th, 1893, permitting the discontinuance of the supply of electrical energy from midnight on Saturday to 6 p.m. on Sunday, and on other days from midnight to 8 a.m., during a period not exceeding two months from the date hereof. The borough accountant reported that in order to assist the engineer and himself in preparing the books for the collection of the electric supply rentals, it would be necessary for the committee to fix the periods for the rendering of the accounts. It was resolved that it be a recommendation to the Finance Committee in making the arrangements necessary for the collection of the rentals that the accounts for the same shall be rendered quarterly. Councillor Broadbent asked if anything had been done with regard to an exhibition of electricity or electric appliances. In reply it was stated that if any manufacturer required to exhibit their manufactures, and took a warehouse or shop in the town, the committee would supply the light.

Captain Ronald Scott and the "Star."—The *Star* last Friday contained the following:—"From five fitters, a turner, and a smith, comes a complaint against the working of the electrical works of Captain Scott at Acton Hill. It is stated that the 'average rate of wages cannot now exceed 3d. or 4d. per hour, and there are over 30 premium apprentices.' It is also alleged that a new foreman signalised his advent by discharging 16 or 18 workmen in the first week of his control, and has been discharging others ever since. On September 19th, continues the complaint, 'one man was discharged for showing an apprentice how to do his work, and then all the fitters who were left in the shop came out.' This is the men's side of the story. In fairness to Captain Scott we give his, as told to a *Star* man who called on him to inquire into the matter. He says the man who was discharged yesterday was impudent to the foreman, as it afterwards transpired because he had another job ready to go to in Cardiff. He immediately went round to four others and got them to apply for their money, which was given them, and they proceeded to picket the gates. They were getting 8d. an hour, which Captain Scott says is more than the work will bear, owing to the cutting of prices by competitors. As to the premium apprentices, he volunteered the information that there were 39 of them, but deplores the fact that many of them would be a clear loss but for the cover afforded by the premium."

Shoreditch Electric Lighting and Refuse Disposal.—The Electric Lighting Committee of the Vestry report that they have considered the reference back to them of their report on the Pitfield Street site, with instructions to make a further financial statement and report. So far as the electric lighting scheme is concerned the committee think that the report of Mr. Manville contains the fullest financial information that can be afforded until a site has been actually acquired. With regard, however, to the dust utilisation part of the scheme, and the amount of heat which would be available for baths and washhouses and motive power, they thought it would be advisable and very useful in a scheme of this magnitude to obtain a financial report from Messrs. Manlove, Alliott & Co., who are stated to be in a position to give accurate results of the actual working of such combinations. The committee have accordingly instructed them to report what results they could guarantee with regard to the cost of burning 20,000 tons of dust per annum, and the amount of heat which would be available for baths and washhouses and electric lighting purpose, and the capital cost of maintenance, for the sum of £10 10s., it being understood that the vestry are not in any way pledged to place any subsequent contract with them.

Sheffield Electric Lighting.—The Sheffield Electric Light and Power Company, Limited, are just now engaged upon the completion of the electric lighting scheme. The central station is in process of construction at the bottom of Commercial Street, and converting stations or transforming chambers have been erected in various parts of the city. In all there will be eight sub-stations. The high tension system has been adopted. As soon as the underground work in connection with the compulsory area is complete, the company will proceed to extend the wire to the Broomhill and Ranmoor districts, where a large demand for the current is anticipated. At present the work connected with the reconstruction of the central station is being vigorously proceeded with. Five Babcock and Wilcox boilers have been already put down, and two additional engines and alternators, manufactured by the Brush Electrical Engineering Company, are being erected. At the central station there are a number of Mordey-Victoria alternators working, at a pressure of 2,000 volts. These are rope-driven from high-speed vertical engines. Effective arrangements have been made for dealing with cases of emergency. Duplicate engines are provided, the company having decided to have a certain percentage of spare plant ready for use when needed. For the last five years the company have supplied currents to various parts of the city. During the extensive alterations which have been rendered necessary of late, owing to the company's policy of extension, there has not been the slightest hitch. The supply of electricity to consumers is made at present from overhead wires, the wires which will supply the city under the new scheme will be underground. The mains have been laid on the Callender Bitumen Company's system.

The Electric Light at Chippenham.—On Tuesday evening Mr. Hathaway, of the Chippenham Churn Works, invited the mayor and members of the corporation, with other gentlemen, to inspect the electric light which has been temporarily fitted up in a large workshop used by joiners in Mr. Hathaway's works, adjoining the extensive premises of the Wiltshire Bacon Curing Company, which is lighted throughout with electricity. The power—a 250 light dynamo—being more than is required, it has been suggested that with a small additional outlay increased power sufficient to light the town and for private purposes could be procured. In the shop above referred to there are three incandescent lamps of 16-candle-power, and over the entrance gate leading into the timber yard one of 200-candle-power. It was pointed out that if the Town Council entertained the idea of lighting the town with electricity, in the first place they should grant permission for the erection of three or four temporary poles to be fixed between the bacon factory and the railway bridge, which should be lighted for a period of two or three months, and which would then give the corporation and the public ample opportunity for expressing their views on the subject.

Incandescent Lamps.—We learn that the General Electric Company, Limited, have acquired the incandescent lamp factory built by the Brush Electrical Engineering Company at Brook Green, Hammersmith, for the purpose of manufacturing incandescent lamps. We are told that the plant now installed and being erected is capable of an output of over one million lamps per annum. The management will be in the hands of Mr. C. J. Robertson, well known as one of the most experienced incandescent lamp makers in England and on the Continent.

We are informed that the Brush Company will, as announced in our advertisement pages, resume the sale of their glow lamps in the United Kingdom on and after November 10th. The lamps are manufactured at other works owned by the Brush Company, and are made under the most modern and improved processes.

School Electric Lighting.—The whole of the rooms on the ground floor of the Huddersfield Technical School have been fitted up for the electric light by Messrs. Scott & Mountain, of Newcastle-on-Tyne, and on Tuesday last week the supply of electricity from the corporation mains was formally turned on by the president. Altogether about 125 incandescent lights have been distributed amongst the ground floor corridors and rooms, which comprise the weaving shed, the dyeing house, the chemical laboratories, and the chemistry, dyeing, and physical lecture rooms. It is contemplated to extend the installation to the whole of the school.

Electric Cranes.—At the last meeting of the Southampton Harbour Board, the Works Committee reported that an offer from Messrs. Statter & Co. to supply some spare parts for electric cranes was not entertained, though permission was given to the firm to make some tests as to the efficiency of these cranes, on the understanding that they would pay for the current supplied. It was explained that the committee felt there was no necessity for purchasing the spare parts, as they hoped to have the other crane working soon, and if anything happened to one, the other could take its place until what was necessary had been done to it.

Electric Lighting at Manchester.—Mr. Walter Leake, consulting electrical engineer of Manchester and Dublin, has been instructed to draw up the necessary plans and specifications for the electric lighting of Messrs. John Heywood & Sons' wholesale stationery premises, Manchester, the installation being for about 800 lights including the necessary generating plant. We also note that the contract for lighting Messrs. Agnew & Sons' well known picture galleries at Exchange Street, Manchester, to Mr. Leake's specification, has been placed with Messrs. Drake & Gorham, of Victoria Street, Westminster, London.

Electric Light at Doncaster.—The new central premises of the Doncaster and District Co-operative Society, opened last Saturday, is lighted by electricity, the dynamo being driven by one of Crossley's 20 horse-power gas engines. Messrs. Ullathorne and Edmondson, of Bradford and Leeds, have very successfully carried out the work.

Chapel Electric Lighting.—The first Wesleyan chapel in London to adopt electric lighting is that at Bayswater. The following is a summary of the lights installed:—Ceiling, 30; choir, 9; organ, 4; pulpit, 6; ground floor, 16; lobbies, &c., 8; total, 73. Candle-Power: 1 5-C.P., 7 8-C.P., 62 16-C.P., 3 32-C.P. The contract for the installation amounted to £101 10s., and the professional charges have been £15 15s. There have, however, been some extras, so that the cost will not be less than £125. The specification and plans were drawn by Mr. Duncan Dundas, of the St. Martin's Electrical Manufacturing Company, 3, Peter's Court, St. Martin's Lane, and the work has been carried out by Messrs. Money & Nash, electrical engineers, Palace Gardens Mansions, Notting Hill.

Electric Light at West Calder.—The opening ceremony of adopting the electric light at West Calder was carried out last week in the premises of the Co-operative Society. The society's plant, which has now been in use for the last four years it is stated, has grown to be a complete central station for distribution throughout the village. A large number of subscribers, who have defrayed the cost of erecting the lamps, assembled to witness the opening ceremony of turning on the current to all the different circuits throughout the village.

Failure of an Electrical Engineer. — A meeting of creditors of Selina Rowbottom, electrical engineer, of 82, Abbey Street, Derby, carrying on business as S. Rowbottom & Co., was held at Derby the other day. The debtor's statement showed liabilities £302 19s.; of which £280 4s. was expected to rank for dividend. The stock-in-trade, which cost £400, was estimated to realise £250, the machinery, £36, trade fittings, &c., £25, furniture, £20, and there were good book debts put down at £26 10s. The alleged cause of failure was bad trade during the past year.

Electric Lighting at Cambourne. — Messrs. Holman Bros. have lighted their large foundry at Wesley Street with electricity. The installation consists of 46 Edison-Swan incandescent lamps, and several Crompton arc lamps, ranging from 2,000 to 500 candle-power. A self-regulating Crompton dynamo is used, driven by a powerful two-cylinder engine, made by the Messrs. Holman Bros. The installation has been successfully carried out by Messrs. Veale and Co., Ltd., St. Austell, under the supervision of Mr. F. H. Headley.

Agency.—Mr. L. H. Bloomfield, of 11, Queen Victoria Street, E.C., has taken over the representation of makers on the Continent of accessories for electric lighting, &c. He will make a speciality of patent "Excelsior" carbons, for which are claimed many advantages; porcelain insulators and parts for lamp-holders, ceiling roses, cut-outs, safety junctions, tubes, &c.; switches and switchboards, glass globes and shades, volt and ammeters, accumulators and portable batteries.

Wrexham and Electric Lighting.—The Town Council have resolved to purchase from the Wrexham and District Electric Supply Company their provisional order for the sum of £250. The words of the Mayor appear to have been lost upon the ears of the councillors, when he stated that for 10 or 12 years the electric light would be an experiment, if they adopted it. They wanted, he said, baths and recreations before an electric light installation.

"Not to be Depended Upon."—There was a discussion at the Barton Board of Guardians meeting regarding a suggestion that the new workhouse be lighted by electricity. The discussion appears to have ended in smoke. The Chairman made some very significant remarks, such as, "Most people who have electric light have gas as well," "Electricity is not to be depended upon."

Berwick and the Electric Light.—Lighting by electricity is making headway in Berwick. Messrs. Johnson & Darlings have used it for some time at their works at Spital; Messrs. Allan Brothers, timber merchants, are erecting the necessary plant at their works at Tweedmouth, and Mr. W. Shiel Dods contemplates introducing it into his business premises at High Street, Berwick.

Monmouth and Electric Lighting.—At a special meeting of Monmouth Town Council last Friday, a complete system of drainage and disposal of sewage, together with the introduction of electric light for the streets and houses, was unanimously resolved upon. The engineer is Mr. C. Nicholson Lailey, Westminster, and the cost will be about £16,000.

Weston-super-Mare Electric Lighting.—At a recent meeting of the Town Commissioners, the tender, plans and specifications of the Brush Electric Light Company, for supplying the district with electric light, were brought forward. The whole matter was referred to a special committee.

Clerkenwell Electric Lighting.—The London Electric Lighting Company have repeated their application for an extension of time to complete the electric lighting undertaking. The Clerkenwell Vestry, in reply, have confirmed their former decision not to grant the request.

Asylum Electric Lighting.—The Govan Lunacy Board have had it reported to them that to light Hawkhead Asylum by electricity would cost £5,300, and the yearly working charges would be £269 5s. The committee, however, have not yet decided regarding the matter.

Claybury Asylum.—Messrs. Cox-Walkers, of Darlington, have secured the contract from the London County Council for the supply and complete installation of electric tell-tales, telephones (over 30 sets), and fire alarms (65 stations) for the new asylum at Claybury.

Falmouth Electric Lighting.—The Falmouth Town Council have had under consideration a report from the Lighting Committee, who announced that they had communicated with Messrs. à Court & Rogers, and Messrs. Veale & Co., electrical engineers, asking for what sum they would prepare a report on the electric lighting of the main streets of Falmouth, and for what additional sum they would supplement the first report by one dealing with the whole of the borough. After due consideration had been given to the matter, and Messrs. à Court & Rogers had been communicated with, it was resolved that Messrs. Veale & Co., be invited to prepare a report.

Yeadon and Electric Lighting.—At a meeting of the Yeadon Local Board last week, a letter was read from Mr. R. Hammond, consulting engineer to the Leeds Electric Light Works, giving the terms on which he would prepare a scheme of electric lighting for Yeadon. The Board decided to have another interview with Messrs. Andrews & Preece, and after that to call a public meeting for the purpose of asking the ratepayers' sanction to the board undertaking the supply of electricity for both public and private lighting.

Personal.—Mr. T. H. Aldridge has obtained an appointment with the Grand Junction Canal Works, at their pumping station at Tring. We are given to understand that he qualified himself for the post in the works of Mr. Ronald A. Scott, at Acton Hill.

Swinton and the Electric Light.—Mr. McNab, of the Swinton and Swinton Morriston estates, is at present fitting up the mansion house of the Swinton estate with the electric light. A firm of engineers from Stirling is doing the work.

Electric Light at Aberdeen.—We are requested to state that the electric installation at Messrs. Harper's Works, Aberdeen, was designed and constructed by the General Electric Power and Traction Co., Limited, Kentish Town, London.

Société Générale des Téléphones.—It is stated that the scheme for the reconstruction of the company has been completed, and will be laid before the shareholders shortly for their approval.

Electric Lighting at Falkirk.—The Town Council have refused to grant the application of the Caledonian Electric Supply Company, Limited, for power to apply for a provisional order.

Telegraphic Communication with South Africa.—Telegrams from Cape Town on 25th inst., report that telegraphic communication with Fort Victoria has been restored.

Whitehaven Electric Lighting.—It is stated by a local paper, that up to the present only 27 applications have been made for a private supply of electric light here.

Change of Address.—On and after October 1st, the office of *L'Electricien* will be 3, Rue Racine, instead of 58, Rue Saint-Andre-des-Arts, Paris.

Mill Lighting.—Messrs. Joshua Hoyle & Son, of Bacup, are arranging for an installation of electric light at their Freehold Mill, Shawforth.

Private Installations.—The premises of Messrs. Beringer & Co., jewellers, Redruth, is now lighted with the electric light.

Electric Light at Aberystwyth.—The Corporation have agreed to transfer to a private company their provisional order.

Cardiff Gas Lighting.—It is stated that 340 of the public lamps have lately given defective light.

CITY NOTES, REPORTS, MEETINGS, &c.

The Petroleum Engine Company, Limited.

THE directors' report for the year ending June 30th, 1893, to be submitted at the meeting of shareholders, to be held on October 4th, 1893, shows that the royalties received for the year amount to £1,271 1s. 6d., which shows a disappointing reduction on the amount earned last year. The directors have carefully investigated the cause of this diminution, and they are convinced, from the perusal of the correspondence between Messrs. Priestman Brothers, Limited, and their agents and customers during the last twelve months, and from independent evidence, that the fact of several engineering firms having brought out petroleum engines in competition with the Priestman oil engine, and having offered these engines at much lower prices than the Priestman engine, has had a prejudicial effect upon the sales. Your directors, while still believing that the Priestman engine is unquestionably the best oil engine in the market, are of opinion that it is necessary that a very considerable reduction in the selling price must be made in order to maintain their sale in the face of the competition of other makers. After the most careful consideration of the whole question, and conferences with the company's licensees, the directors have entered into a provisional arrangement with Messrs. Priestman Brothers, Limited, subject to the confirmation of the shareholders of the company, that a reduction of 25 per cent. should be made on the original list price of the engines in consideration of this company consenting to a modification of the royalties payable under the existing license. Against this modification, however, the licensees agree to extend the term during which royalties are payable by them for a further term of five years, thus ensuring a valuable prolongation of the life of this company. The directors also hope that the increased turnover arising from the reduced price will speedily more than make up for the reduction in the royalty to be paid. Full details of the arrangement referred to will be submitted to the meeting, and a copy of the letter embodying the terms may be seen by any independent shareholder calling at the company's office prior to the meeting. Under the existing circumstances, the directors have reduced the amount payable to themselves for fees for the past year to £50 each, instead of £100, as prescribed in the articles of association. As the expense of patent renewal fees is considerable, the directors have decided, with the consent of the licensees, to allow certain patents to lapse which they believe to be not essential to the success of the invention. A resolution of the shareholders sanctioning this will be submitted to the meeting. The amount standing to the credit of revenue account, including the balance brought forward from last year's account, is £894 13s. 3d. The directors recommend the declaration of a dividend on the 18,754 shares of the company at the rate of 6d. per share, free of tax, for the year ending June 30th last, which will absorb £481 1s. 2d., leaving the balance of £413 12s. 1d. to be carried forward to next year's account. The retiring directors are Mr. Jarvis W. Barber and Mr. Chas. B. B. McLaren, M.P., who are eligible for re-election. The auditors, Messrs. E. L. Ernest & Co., retire, and are eligible for re-election.

The Halifax and Bermudas Cable Company, Limited.

THE report of the directors, which was presented to the fourth annual general meeting of the company, held at No. 33, Old Broad Street, E.C., on Wednesday, September 20th, reads as follows:—

"The directors beg to submit to the shareholders duly audited statements of accounts for the year ending June 30th 1893. The result of the working is a profit of £1,717 8s. 5d. as compared with £1,261 14s. 2d. for 1891-2. To this has to be added the balance of £1,681 19s. 7d. brought forward from last year, making the sum to the credit of revenue £3,399 8s. The net cable receipts in the past year were £4,856 14s. 8d., as compared with £3,915 13s. 3d. in the preceding year. This increase is chiefly due to a greater number of vessels calling at Bermuda for orders and to refit. The growth of this business is very advantageous to Bermuda, and it is the direct result of the establishment of cable communication. Other sources of traffic have been maintained. The company's cable has throughout the year worked with complete efficiency, and its electrical condition is excellent. The directors have during the year continued to give their attention to the one or two outstanding matters of an unsatisfactory character, due to the early experience of the company. The loan of £9,000 had of the Gresham Life Office at 6 per cent. has, since June 30th, been still further reduced to £6,800, and the rate of interest to 5 per cent. Further, the £10,153 16s. 10d. which appeared in the last balance-sheet as debit against capital account has been reduced to £6,754 8s. 10d., by the application of the £3,399 8s. to credit of revenue account. The fund for the redemption of the debentures is now £7,995 6s. 2d. as compared with £5,175 16s. 9d. last year. Under the articles of association Mr. T. G. H. Glynn and Mr. Thomas Skinner retire on this occasion, and offer themselves for re-election. The auditors, Messrs. Gribbon, Ingram & Holroyd, retire in accordance with the articles of association, and they offer themselves for re-election."

We are informed that at the meeting the report was unanimously adopted.

Stock Exchange Announcements.—The Stock Exchange Committee have (1) appointed special settling days as under: Friday, September 29th, Metropolitan Electric Supply Company—further issue of £50,000 5 per cent. debentures, Nos. 5,001 to 10,000, and (2) ordered the undermentioned securities to be quoted in the official list:—Brush Electrical Engineering Company, Limited—further issue of 15,000 preference shares, Nos. 75,001 to 90,000; 12,022 ordinary shares, Nos. 77,979 to 90,000. Metropolitan Electric Supply Company, Limited—further issue of £50,000 5 per cent. debentures, Nos. 5,001 to 10,000.

Eastern Telegraph Company, Limited.—The payment on October 13th next of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the preference shares of the company, is announced for the quarter ending September 30th; also the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended June 30th. The register of transfers will be closed from October 6th to 13th, both days inclusive.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of the Anglo-American Telegraph Company, Limited, held last week, it was resolved to declare an interim dividend for the quarter ending September 30th, 1893, of 12s. 6d. per cent. on the ordinary stock, and 25s. per cent. on the preferred stock, less income-tax, payable on November 1st to the stockholders registered on the books of the company on September 30th, 1893.

TRAFFIC RECEIPT.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 22nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £8,923.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, September 20th.	Closing Quotation September 27th.	Business done during week ended September 27th, 1893. Highest.	Lowest.
184,500	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,134,640	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	50	...
2,932,680	Do. do. 6 p. c. Preferred	Stock	92 — 93	92 — 93	93	92¼
2,932,680	Do. do. Deferred	Stock	9½— 10	9¼— 9⅝	9⅝	9 5/16
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12	11½ — 12	11⅞	11⅝
18,700	Do. do. 5 p. c. Bonds	100	99 —103	99 —103	...	...
75,000	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ - 3⅛	2⅞ - 3⅛	...	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ - 2⅜	2⅛ - 2⅜	2⅛	...
125,000	Do. do. 4½ per cent. Debenture Stock	Stock	106 —108	107 —109	...	...
20,510*	{ Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000 }	5	5 — 5½	5 — 5½	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000	City and South London Railway	Stock	35 — 37	34 — 36	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11¼ — 11⅜	11⅛ — 11⅜	11⅜	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12¼ — 13	12¼ — 13	12⅞	12 9/16
$7,716,000	Commercial Cable, Capital Stock	$100	135 —140 xd	135 —140	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	10/-	1/16 — 3/16	1/16 — 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	3½ — 4½	3½ — 4½	...	...
50,000	{ Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each }	...	98 —102	98 —102	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ - 3⅛xd	2½ — 3⅛	...	...
6,000	Do. do. 10 p. c. Preference	5	8½ - 9½xd	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ - 11⅝	11⅜ - 11⅝	11⅞	11⅝
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15½	15 — 15½	15½	15⅛
70,000	Do. 6 p. c. Preference	10	16 — 16⅛	16 — 16⅛	16⅜	16⅛
105,900	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	...	...
1,294,100	Do. 4 p. c. Mortgage Debenture Stock	Stock	111 —114	112 —115	114	112⅜
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15¼ - 15⅛	15¼ — 15⅛	15 7/16	15⅛
62,700	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	1 2 —105	102 —105	...	...
222,800	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000	Do. 4 p. c. Debenture Stock	Stock	110 —113	110 —113	111½	...
108,700	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 —104	101 —104	...	...
146,800	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
300,000	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1903	100	101 —104	101 —104	102⅛	...
200,000	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	103 —106 %	103 —106 %	104⅛	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1½ - 1⅝	1½ - 1⅝	1 7/16	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛ — ⅜	⅛ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 10	9⅜ — 9⅞	9 13/16	9 11/16
150,042	Do. do. 6 p. c. Preference	10	15½ — 15⅝	15⅝ — 15⅝	15⅝	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	20 — 20½	20 — 20½	20⅜	...
200,000	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	103½	...
12,134	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ - 22½	21½ — 22½	22 5/16	22½
200,000	Do. do. 4½ p. c., Deb., 1896	100	103 —105	101 —103	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 42	39 — 42	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4⅛ — 4⅜xd	4⅛ — 4⅜	4 1/16	4 1/16
10,000	Do. do. fully paid	5	6 — 6⅛xd	6 — 6⅛	6⅛	5⅞
37,500	Liverpool Overhead Railway	10	5¼— 5½	5¼— 5½	8½	4⅜
27,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅞ - 7⅛	6⅞ 7⅛	7⅛	7
50,000	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —107	104 —107	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1⅛— 2⅛	1⅛— 2⅛	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
438,867	National Telephone, Limited, Nos. 1. to 438,984	5	4⅛ — 4⅜	4⅜ — 4⅞	4 13/16	4 9/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½ - 14½	13½ — 14½	14½	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅛— 5⅜	5⅛— 5⅜	5 5/16	5⅛
726,477	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —114	112 —114	113½	113
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
100,000	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	100 —103	101 —104	...	...
11,802	Reuter's Limited	8	4½ — 5½	4½ — 5½	...	...
19,930	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6½ — 6⅝	6½ — 6⅝	6 9/16	6⅝
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	7⅞ — 8⅛	8 1/16	8
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	118	117½
78,942	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 — 2½	2 — 2½	2⅜	2 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	32 — 34	32 — 34	33¾	33
150,000	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 — 100	...	..
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ - 6½	...	...
260,900	Do. do. do. 5 p. c. Debentures	100	97 —100	97 —100	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —101	97 —101	99½	99½
64,242	Western and Brazilian Telegraph, Limited	15	6½— 7	6½ — 7	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅞ - 6⅛	5⅞ - 6⅛	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅛ - 1⅜	1 — 1⅛	...	...
178,000	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 - 106	103 —106	...	...
222,700	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	
88,321	West India and Panama Telegraph, Limited	10	1⅛ - 1⅜	1⅛ — 1⅜	1 5/16	1⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10⅛ - 10⅜	10 — 10⅛	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 —10	9 — 10	...	...
80,000	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	106 —109	106 —109	...	...
$ 214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	115 —120	115 —120	...	...
160,000	Do. do. 6 p. c. Sterling Bonds	100	101 —104	101 —104	104⅛	...
99,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	4⅜— 5⅛	5 — 5⅛	5⅛	5 1/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully 5—5⅛.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 100—103.—Electric Construction Corporation 6 per cent. Debentures, 95—98.—Electric and General Investment, shares of £5 (£1 paid), 1⅜—2⅛.—Founders' shares, 200—235.—Electricity Supply Corporation, Ordinary of £5, 5—5⅛.—House to House Company (£5 paid) 1⅜—2⅛.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—5⅝, 1st Preference Cumulative 6 per cent., £5 (fully paid) 6—6⅛.—Manchester, Edison and Swan Company £9 (£1 paid), ⅜—½.—Queen Anne's Mansions Lighting and Heating 6 per cent £100 Debentures, 101—102.

Bank rate of discount, ½ per cent. (September 21st, 1893.)

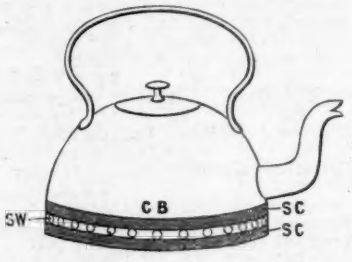
RECENT ADVANCES IN ELECTRIC HEATING.

THERE have been many attempts to make heating by electricity of practical use, and while there can be no denying that electricity will effectually perform all the functions of fire, gas, or other heating systems, the problem that has hitherto remained unsolved is the prohibitory cost. We would point out that the resistance method seems to have been the only one which has been considered commercially. So far as we know, there have been no attempts to prove the practical value of the suggestions of Zipernowski, Rankin Kennedy, and others. As we mentioned in the ELECTRICAL REVIEW some time ago, M. Zipernowski dispenses with resistance wires, and uses the principle of the semi-incandescent lamp; thus if a copper soldering bolt is brought into contact with the tip of a carbon point, and a current passed through, a great heat is generated at the point of contact. The method suggested by Mr. Rankin Kennedy seems, at first sight, to have much to recommend it, because costly utensils are unnecessary. In this arrangement the induction by alternating currents of secondary currents in the articles to be heated is made use of. For example, if an iron pipe, closed at one end, is filled with water, and a coil of wire carrying an alternating current is wrapped round the pipe, the water soon boils. There would be no difficulty in using this system for cooking purposes, for vessels in which articles are cooked would not need special preparations of wires. It will be urged that this arrangement could only be employed where alternating currents are used; but alternate current circuits are common enough to warrant this method having a fair trial.

HEATING BY THE RESISTANCE METHOD.

It must be admitted that in the past, heating and cooking by electricity have been relegated to the regions of the unscientific. Engineers have been prone to regard the efforts of those who were endeavouring to popularise cooking and heating by electrical means, as the harmless recreations of elderly females. Doubtless many of our most eminent electrical men might have had worse employment than that of calculating the exact number of heat units desired by a well done chop. Our view is that nothing is too mean for consideration which bids fair to increase the load of a central station. Indeed, we look forward to the day when a cooking curve, not a "cooked" one, will form part of a central station log-book. Heating by the resistance method is very old, but it is only in these days of central station supply that the matter of cooking and heating has been considered. Some two years ago, we believe it is, that Prof. Ayrton announced, from the rostrum of the Royal Institution, to the *élite* of the scientific world, that the cost of cooking a pancake by electricity was a penny; perhaps the insulating material used in this case was poor, or the material of which the pancake was composed was refractory. This, at any rate, was improved on at some fairly successful cookery performed at the Crystal Palace Exhibition last year. The efficiency, however, obtained was very small, and the wires used in the apparatus were soon destroyed. These were the points on which improvements had to be effected before the question of cookery could be considered seriously, and to them Mr. Binswanger, of the General Electric Company, has turned his attention, and he claims to have obtained nearly theoretical efficiency, besides lasting qualities for insulating material and wires. There were three main questions confronting the advocates of heating—they had to secure the best insulating material, the most suitable resistance, and the construction of the apparatus had to be carried out in such a manner that the greatest effect was obtained on a given spot and the best means adopted of retaining the heat. Two distinct types of insulators have been most commonly used for this purpose; the first was simply wrapping the wires with such substances as asbestos, mica, &c., the other was to imbed the wires in enamel. It has been found that in the first of these methods the wires become rapidly oxydised; in the second, the enamel had the serious drawback of cracking, it would not stand very high temperatures, and could only be applied to surfaces which had a higher melting point than itself, so that such surfaces as copper or silver could not be used. Mr. Binswanger thinks that he has overcome these difficulties by employing a cement which can be applied in a cold state, and which retains its insulating properties without cracking under the greatest heat. It can be applied to any substance direct, and has the advantage, it is said, of quickly transmitting heat to the body to be heated. As to the question of retaining heat in a closed receptacle such as an oven, Mr. Binswanger has carried out a great many experiments, and he is convinced that to construct an efficient baking oven to be worked by electricity, it will be necessary to discard the opinions which predominate, and make an apparatus quite different to what has been done hitherto. The expedient of making an oven of double sides, lagged between the two sheets with asbestos for the purpose of retaining the

ELECTRIC KETTLE.



C B, Copper bottom; S C, Silicate cement; S W, Specially drawn copper wires.

SECTION OF KETTLE.

heat, is useless. It is found that the lagging acts as a conductor. What he considers to be the best arrangement for an electric oven is to obtain some surface which can be kept

ELECTRIC STEW PAN.

bright and smooth either outside or inside, to prevent radiation; if it is necessary to have a second receptable or cover round, the lagging should not be of any substance but of air, which, however, must be in a state of rest.

HEATING OF WATER.

For heating water, kettles are constructed of varying expenditures of current in watts. The 1 pint size usually takes 3 ampères at 100 volts. The time necessary to raise a pint of water from 60° to 212° F. by an expenditure of 1,000

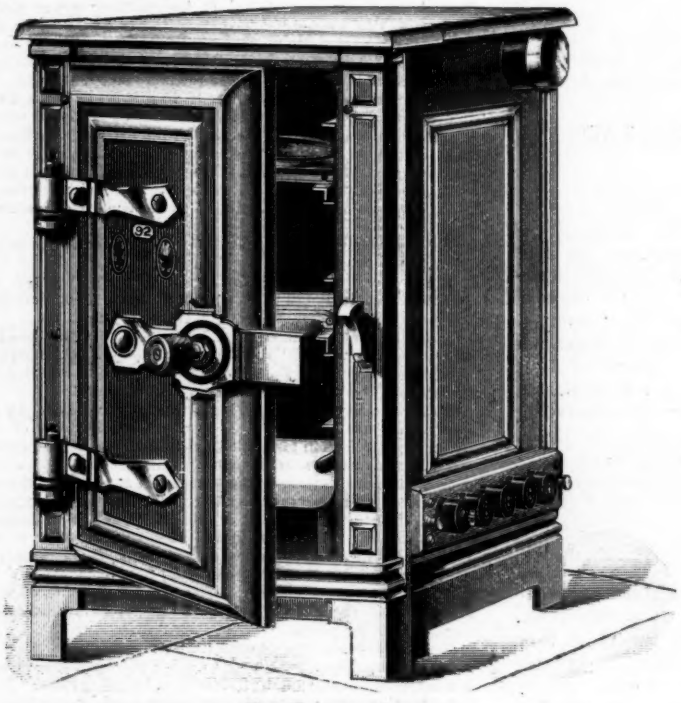
watts is 3·7 minutes—the 300 watt kettle will, therefore, take 12 minutes to boil 1 pint. Taking the price of electricity at 6d. per unit, the cost works out at ·36d., or ·24d. at 4d. per unit, per pint of water. This is certainly much better than we should have expected, and though it cannot compare with the cost of boiling a pint of water by gas, it is practical enough for many people who have electricity laid on to their homes. The arrangement of the wires and insulation is shown in the accompanying drawing.

Stewing and other Culinary Operations.

The process of stewing by electricity has been a subject which has required considerable expenditure of thought. The difficulty of regulation was met with in this case. Stewing operations are carried on first of all with considerable application of heat, and afterwards there is the simmering process. Certainly regulation could be effected by outside resistance, but this would be wasteful. So the difficulty has been solved by wiring in parallel two or three different circuits, the use of which supply the varying temperatures necessary in the process of stewing. In the same way the arrangements are effected for stewing by steam. We illustrate two or three specimens of utensils with two circuits.

It is in the frying or grilling operations that electricity has been found to be most economical, for heat can be produced in the very spot wanted. The frying of cutlets and chops is speedily and economically performed. Four or five cutlets, it is said, can be cooked with an expenditure of 300 watts for 12 minutes; the cost being, at 6d. per unit, ·4d. We can personally vouch for the fact that a cutlet was cooked during our visit, and the time taken was a little less than 12 minutes. The frying pan would have accommodated four more chops, and we are informed that there would have been no more expenditure of energy. It must be pointed out that this 12 minutes included getting the pan to the necessary heat.

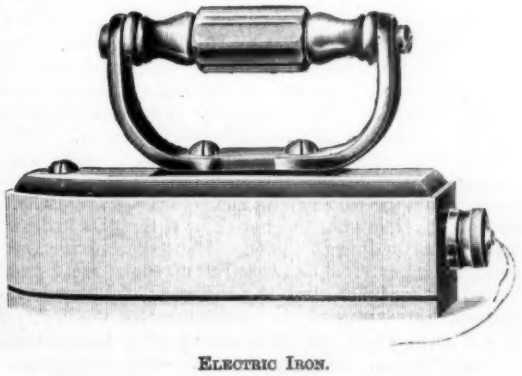
The electric ovens are usually provided with five circuits placed at the top and sides; each circuit takes 4 ampères.



The Electric Oven.

Electric Coffee Pot.

Electric Radiator.



Electric Iron.

The makers claim that they can obtain a heat of 400° with 20 ampères in about 15 minutes, and retain the heat for a long time after switching the current off. It is expected that the air jacketing and bright surface which is now being adopted will effect great economy, and that 10 ampères will be quite sufficient for ordinary cooking.

The heating of irons for pressing work seems to be effectively performed by electricity, and certainly offers considerable advantages over gas and fire. The heating of rooms is done by radiators, an illustration of which is given. It is found that with a current of 6 ampères an ordinary room, 12 feet by 10, can be well heated.

At the present moment the most serious obstacle in the way of electric heating is the somewhat high price of the utensils; for instance, an electric kettle could not be obtained for much less than 30s. Of course, a large demand for these things would immediately cheapen the cost.

Our illustrations show an electric oven, a stew pan, radiator, kettle, tailor's goose and a coffee pot, the working of which has been fully explained.

Sufficient has been said to show that the applications of electricity for heating and cooking purposes is practical, and it only needs the cheapening of electricity to bring electric cooking within the use of all consumers of electricity. No doubt Mr. Binswanger will endeavour to still further improve his apparatus, and eventually succeed in approaching theoretical efficiency.

BOILERS AT THE WORLD'S FAIR.

I.

In a paper in *Cassier's Magazine*, by Mr. York, of the United Electric Light and Power Company, we are first treated to a florid statement of what the 30,000 horse-power concentrated at Chicago implies in the way of fuel and water, much upon the basis of the "penny-a-liner" who runs into figures upon the number of hogsheads of water contained in the ocean and the period of time necessary to empty it through a pipe of a mile diameter. He then states that the water-tube boiler was selected as the only properly safe boiler admissible, and adds it has proved this by years of practical demonstration—a somewhat sweeping assertion. It appears that there are eight makes of boiler on view at Chicago, of which the "Root" boiler is first named as being one of the oldest. As now made, the inclined tubes of the "Root" boiler are wholly below water level, the water being carried in a series of horizontally placed drums of small diameter placed above the inclined tubes. In other respects, and in general form, the boiler differs little from other makes of the water tube type, and is not one which can be recommended as suitable for the smokeless combustion of bituminous coal, nor for scaling waters. It is essentially a boiler for coke or anthracite, and doubtless from its place of manufacture (New York) was designed for such fuel.

The "Babcock" boiler is next described; it has been largely installed at Chicago.

The "Climax" boiler follows. One of 500 H.P., or capable of evaporating 15,000 pounds of water per hour, stands 30 feet high, and is 13 feet diameter; the 1,000 horse-power boiler being 37 feet by 15½ feet diameter. This last named boiler contains 1,000 three inch tubes, each 12 feet long, and has 10,000 feet of heating surface to evaporate 30,000 pounds of water per hour. This boiler consists of a central cylinder with a smaller inner cylinder. The tubes spring from the outer cylinder radially, curve round a portion of the circumference of the extreme outer casing which holds the whole affair, and return again radially to the outer cylinder, but are lead across by short tubes to draw their water from the inner cylinder. The space between the outer cylinder and external casing is full of the furnace products. This boiler is indeed fearfully and wonderfully made, though perhaps less expensive than its illustration would imply, for it is a boiler which can be made up of a large number of identical pieces. It ought to have clean feed water. We have long since ceased to respect the statements made by water tube boiler "cranks," that they secure so thorough a circulation that no deposit forms in the water tubes.

The "Stirling" water tube boiler is of quite a different kind; it has three upper or steam drums, and one lower or mud drum, connected to the upper drums by three lines of highly inclined, almost vertical and slightly curved for the purpose of avoiding the action due to expansion, tubes, if we may use the Teutonic mode of description. All the boilers thus described have probably a generating power out of proportion to their water capacity, and, as such, will have the quick steaming powers, which with some minds pass for efficiency. They are unlikely to give steady pressures except where existing in numbers sufficient to counteract their individual unsteadiness, and whatever may be the boiler of the high pressure future, we do not think it has been described in this first paper.

THE DEVELOPMENT AND TRANSMISSION OF POWER FROM CENTRAL STATIONS.*

By Prof. W. CAWTHORNE UNWIN, F.R.S.

The striking success achieved in transmitting power electrically to great distances has tended to obscure the fact that other methods of power transmission are more convenient and less costly in particular cases. The remarkable mechanical and scientific success of the Frankfort-Lauffen experiment, in which 300 horse-power was conveyed 108 miles with a loss of only 25 per cent., has a little misled merely popular observers. The fact must be borne in mind that the cost of the power when it reached Frankfort was five times as great as that of an equal amount of power produced directly in Frankfort by a steam engine. Transmissions to much smaller distances are the only ones likely to be often required, and for moderate distances there is choice of various methods of transmission besides the electrical method.

The advantages of generating power at central stations may be enumerated thus:—

1. In generating power by steam there is economy of cost of machinery, of fuel, and of superintendence due to concentration of the engines and boilers in a single station.

2. In the case of water-power, very often it is only possible to deal with a natural waterfall by a combination of consumers, or by an association acting in the interest of many consumers for the construction of the costly permanent works required.

3. The locality for generating power may be fixed by one set of conditions; that where it is used by another set of conditions. Often it is a question of adopting a cheaper source of power at a distance, or a dearer near at hand. Thus in mining and tunnelling operations, cheap steam-power, generated at the ground surface, may be distributed in the workings to replace much more expensive hand labour. That is essentially a case of power distribution from a central station. Mr. Thwaite has recently proposed to erect large gas motor stations at collieries, and to transmit the power electrically to the nearest manufacturing centres.† Whether that is desirable is a question of finance entirely. The question is whether the economy in producing the energy covers the cost of its transmission to a distant working point.

4. Another reason for central stations arises in this way. For good or for ill, population gathers into huge communities in which there is a complex development of social and industrial life. In such communities there is a constantly increasing need of mechanical power. For transit, for handling goods, for small industries, for lighting, water supply, and sanitation, new demands for mechanical power arise. At first these are met by the erection of scattered motors. This sporadic production of power is extravagantly wasteful, costly, and inconvenient. There is a chance in such cases that power distributed from a central station may be cheaper even when the cost of distribution is allowed for.

For the single purpose of working lifts and hoisting-machinery, it has already proved remunerative to extend through the streets of London a system of nearly 60 miles in length of hydraulic mains. In no instance has the use of hydraulic power, when once adopted, been abandoned in favour of any other system of working hoisting-machinery. At Geneva the water is pumped by turbines in the Rhone, and, in 1889, motive power distributed on the high-pressure system amounted to 1,500,000 horse-power hours, there being 79 motors, aggregating 1,279 horse-power; the charge is ·7d. per horse-power hour.

Even under favourable test trial conditions, and with an economical load, there is considerable variation in the amount of coal and steam required per horse-power.

Taking the most favourable results which can be regarded as not exceptional, it appears that in test trials, with constant and full load, the expenditure of steam and coal is about as follows:—

	Per Ind. H.P. hour.		Per effective H.P. hour.	
	Coal. lbs.	Steam. lbs.	Coal. lbs.	Steam. lbs.
Non-condensing engines... ...	1·80	16·5	2·00	18·0
Condensing engines	1·50	13·5	1·75	15·8

These may be regarded as minimum values, rarely surpassed by the most efficient machinery, and only reached with very good machinery in the favourable conditions of a test trial.

It is much more difficult to get the consumption of coal by engines

* Abstract of Howard Lectures delivered before the Society of Arts.

† The *Engineer*, December 2nd, 1892.

in ordinary daily work. What is known shows that the consumption is greater than in engine trials. Some comparatively large pumping engines, which work with a steady load night and day, and which worked with 2 lbs. of coal per effective or pump horse-power on a test trial, used 2·7 lbs. in ordinary working. The consumption was measured over many weeks, during which they were working 90 per cent. of the whole time. Here the consumption is 35 per cent. greater in ordinary work than in a test trial.

If such a case as that of an electric lighting station is considered, where the load fluctuates very greatly, the maximum load being often four times the mean load, and the minimum load $\frac{1}{10}$th of the mean load, then the consumption per horse-power is very much greater. Mr. Crompton has given the figures for the Kensington station, which has excellent Willans compound non-condensing engines. Those engines will work with less than 2 lbs. of coal per effective horse-power in trials at full load. The results obtained in ordinary workings were as follows:—

Year.	Coal used in lbs. per hour.		
	Per electrical unit generated.	Per effective H.P.	Per indicated H.P.
1886	12	8·4	6·5
1890	8	5·6	4·35
1892	7	4·9	3·8

Probably up to the present the consumption has in no case been less than 6 lbs. per unit generated; 3·8 lbs. per effective horse-power, or 3·3 lbs. per indicated horse-power. This large consumption will be traced later to two classes of waste, engine waste and boiler waste, due both of them to the inefficiency caused by variation of load.*

In the case of small isolated motors, not generally of very good construction or well proportioned for their work, still more extravagant results have been observed. The following table gives some results obtained with small workshop engines in Birmingham:—

Nominal H.P.	Probable I.H.P. at full load.	Actual average I.H.P. during the observations.	Coal consumption in lbs. per I.H.P. hour during the observations.
4	12	2·96	36
15	45	7·37	21·25
20	60	8·20	22·61
15	45	8·60	18·13
25	75	23·64	11·68
20	60	19 08	9·53
20	60	20 00	8·50

These last results are interesting only for this reason, that it is such uneconomical small engines which are displaced when central station power distribution is introduced. It is because these small engines are so extravagant that power can be distributed from a central station at a profit. As to the case of electric light stations, seeing that they are central stations of the type specially considered in these lectures, it is desirable to analyse more in detail the causes of waste.

With the range of temperature practically available a steam engine might convert three-eighths, and a gas engine one-half of the heat supply into work. No actual engine reaches even approximately this thermal efficiency.

In questions of power distribution, it is clear that it is the effective horse-power delivered at the crank shaft, and not the indicated horse-power developed in the cylinder, which has to be considered. It is due to the difficulty of determining in most cases the mechanical efficiency of an engine that engineers have been content to reckon on the indicated horse-power. It is true that the engine friction is not a very large fraction of the power developed in full load trials, nor does this fraction vary very greatly at full load for different engines. But it is erroneous to assume tacitly that the engine friction is, in all cases, a quantity of relatively little importance, or that it is immaterial whether the indicated or the effective horse-power is used in calculations.

The mechanical efficiency of steam engines, or the ratio of the effective to the indicated power at full load is 0·8 to 0·85 for small engines and may reach at least 0·9 for large engines. It is a little greater for non-condensing than for condensing engines, and for simple than for compound. A triple expansion engine, constructed by Messrs. McLaren, tested on a brake, gave 122 indicated horse-power, and 107 on the brake, an efficiency of 0·88. The loss of power due to engine friction is not very great or variable, so long as the engines are worked at full load. It is quite otherwise, however, at light loads, and the extent to which this affects the economy of working has been overlooked.

Many experiments show that the engine friction is nearly the same at all loads. Suppose that at full load an engine gives 100 indicated horse-power and 85 effective horse-power. If the friction is constant, then for smaller loads the efficiency diminishes as follows:—

Indicated H.P.	Effective H.P.	Efficiency.
100	85	·85
75	60	·80
50	35	·70
25	10	40

The steam and coal used depend on the indicated power—the work done on the effective power. The decrease of mechanical efficiency for light loads has a serious effect on the economy of working with a varying load.

Careful experiments on mechanical efficiency with varying loads are very numerous. It is useful, therefore, to give the results of some experiments on a Corliss engine of about 180 indicated horse-power at full load. This engine was tried with a brake at Creusot, both condensing and non-condensing. It was found that the results agreed approximately with the following equations:—

Condensing ... ... $T_e = 0{\cdot}902\ T_i - 16$

Non-condensing ... . $T_e = 0{\cdot}945\ T_i - 12$

equations which give results not differing greatly from those obtained by assuming the friction constant. The following are the calculated values of the efficiency:—

Actual effective power.	Mechanical efficiency.	
Power at full load.	Condensing.	Non-condensing.
1·0	·82	·86
·75	·79	·83
·50	·74	·78
·25	·63	·67
·125	·48	·52

Besides engine friction, there is another waste of energy in the steam engine which has, to an even greater extent, been overlooked. The effective power is less than the indicated power by the engine friction; but the indicated power itself is less than the work done by the steam by the amount of work done against back-pressure.

In condensing engines the back pressure is comparatively small, but in non-condensing engines the back pressure exceeds 15 lbs. per square inch. Its influence on economy, even at full load, is considerable, and at light loads it may become excessively great.

In engines working as most engines do, at constant speed, the work against back-pressure is nearly independent of the load.

Suppose in a non-condensing engine the work against back-pressure is 20 per cent. of the absolute indicated work of the steam at full load. Then for other loads the work is distributed thus:—

Absolute indicated work of steam.	Work against back pressure.	Net or effective indicated work.
H.P.	H.P.	H.P.
125	25	100
75	25	50
50	25	25
37½	25	12½
25	25	0

The following is calculated from the indicator diagrams of a compound engine working at nearly constant speed with a varying load. The waste work against atmospheric pressure is calculated exclusively of the waste of work due to excess back-pressure due to resistance of passages, &c. It represents, therefore, work wasted in a non-condensing engine, which is almost entirely saved in a condensing engine.

No. of trial.	Effective work in H.P.		Total effective work, H.P.	Work wasted against atmospheric pressure, H.P.
	H.P. cylinder.	L.P. cylinder.		
1	41·1	28·9	70·0	98 5
2	49 3	38·4	87·7	100 0
3	68·7	48·6	117·3	102 0
4	64·4	60·2	124·6	103 0
5	87·2	78·2	165·4	102·0
6	90·4	90·1	180 5	100 0

The work wasted is equal to $\frac{8}{9}$ths of the effective work at full load, and to $\frac{1}{9}$ths of the effective work at the lightest load.

It has already been pointed out that there are very large thermal losses in heat engines which are not shown on the indicator diagram, and which have a very important effect on economy of working. Those thermal losses are greater also at light loads than at full load, and they vary very much with the type of engine and some other conditions of working.

There are three ways in which the conditions of working may be varied when the power demand varies. The speed may be varied, as is often done in the case of pumping engines. The initial steam pres-

*The latest Board of Trade returns from electric lighting stations confirm these figures. Taking the largest and best stations, the consumption of coal varies in different cases from 7 lbs. to 12 lbs per unit of electricity generated. It is more than this per unit sold.

sure may be varied, which alters the weight of steam used per stroke by altering the density of the steam. This may be done by varying the boiler pressure, or by throttling the steam. Lastly, the expansion may be varied.

In the discussion on Mr. Crompton's paper,* the late Mr. P. W. Willans first stated a remarkable simple approximate law for the total steam consumption of an engine working at constant speed with a constant ratio of expansion. He found that the total weight of steam used per hour for any engine in the conditions stated was given by a linear equation of the form—

$$w = a + b \text{ H.P.}$$

where H.P. is the horse-power at which the engine works. Thus, for an engine of 100 indicated horse-power at full load, he obtained the following equations, in which I.H.P. is put for indicated horse-power, and E.H.P. for electrical horse-power, which is taken at 80 per cent. of the indicated power:—

Non-condensing Triple (about 6·7 expansions).

$$w = 450 + 13{\cdot}75 \text{ I.H.P.}$$
$$= 725 + 13{\cdot}75 \text{ E.H.P.}$$

Non-condensing Compound (about 4·45 expansions).

$$w = 525 + 16{\cdot}25 \text{ I.H.P.}$$
$$850 + 16{\cdot}25 \text{ E.H.P.}$$

Condensing Triple.

$$w = 112 + 13{\cdot}75 \text{ I.H.P.}$$
$$= 377 + 13{\cdot}75 \text{ E.H.P.}$$

If, instead of calculating the total steam per hour, w, we calculate the steam per horse-power hour, we get results which, plotted like the previous diagrams, give rectangular hyperbolas, curves which agree closely with the theoretical curves for the case of varying pressure previously given. To show the great variation of steam consumption, these values are given in the following Tables for full load, half load, quarter load, and one-eighth load:—

STEAM CONSUMPTION, LBS. PER I.H.P. HOUR, AND LBS. PER ELECTRICAL H.P. HOUR.

Indicated H.P.	Non-condensing.		Condensing triple.
	Compound.	Triple.	
100	21·5	18·2	14·9
50	26·7	22·7	16·0
25	37·2	31·7	18·2
12½	58·2	49·8	22·7
Electrical H.P.			
80	26·9	22·8	18·5
40	37·5	31·9	23·2
20	58·7	50 0	32·6
10	101·2	86·2	51·4

With a varying load the steam consumption, and consequently the fuel consumption also, is increased (1) in consequence of the decreased mechanical efficiency of the engines with light loads; (2) by the greater proportion the work expended in overcoming back pressure bears to the total work of the steam; (3) by the diminished thermal efficiency of the engine. But all these causes taken together do not explain fully the great fuel consumption in such cases as electric lighting stations. There is another very obvious cause of uneconomical working which cannot at present be estimated quantitatively for want of sufficient experimental investigation. With a very varying load, boilers must be put in steam and banked up alternatively, and the waste in getting up steam and allowing the boilers and brickwork to cool down again is no doubt considerable. This waste is at present unavoidable, except so far as means can be adopted to improve the load line.

Perhaps the fairest way of considering the waste due to variable load will be to compare the mean consumption in the 24 hours with the consumption between 6 p.m. and midnight, when the load was heaviest. The mean steam consumption per electrical horse-power hour, under these conditions at the Millbank Street Station of the Westminster Electric Supply Corporation, was 24 per cent. greater than during the period of heavy load. But the mean consumption of coal per electrical horse-power hour was 46 per cent. greater than during the period of heavy load. The difference of 22 per cent. must be attributed to waste at the boilers, due to irregular working. During the whole 24 hours the mean evaporation, in pounds of water per pound of coal, was only 85 per cent. of the evaporation during the period of maximum load.

COST OF STEAM-POWER.

With engines of 100 horse-power or more, the cost can be pretty definitely stated, and the total cost of engines and boilers per horse-power does not vary very greatly with the type of engine adopted.

It will be assumed for the following estimates that the total cost, erected, of engines and boilers, with pipes and auxiliary apparatus, and such buildings as are necessary, may be taken to be as follows:—

COST OF STEAM PLANT.

Indicated H.P.	Cost per I.H.P. in £.	Effective H.P.	Cost per H.P. in £.
1	56	·7	80
10	30	7·5	40
50	24	40	30
200	20	165	25

* *Proceedings* Inst. Civil Engineers, Vol. cvi., p. 62.

In determining the annual cost, interest will be taken at 5 per cent., and maintenance (repairs) and depreciation at 7½ per cent.

In the following estimates coal will be taken at 20s. per ton. The amount of coal required must be calculated so as to allow for lighting up boiler furnaces; for waste due to cooling of boilers and brickwork when steam is let down; and for working auxiliary apparatus such as feed pumps.

WORKING COST OF STEAM PLANT.

Indicated H.P.	Coal per I.H.P. hour.	Effective H.P.	Coal per effective H.P. hour.
	lbs.		lbs.
1	8	·7	11½
10	5½	7·5	7
50	2¾	40	3½
200	2·0	165	2½

The cost of petty stores will be taken at 0·25 lbs. per effective horse-power per annum in the case of moderately large engines working 10 hours a day. In other cases a proportionate estimate will be made.

For driving, stoking, and cleaning, an allowance of £1·2 per annum per effective horse-power for 3,000 hours, or £0·6 per annum for 1,000 hours, will be made. In the case of engines of 10 horse-power or less, however, the labour reckoned on the horse-power costs considerably more.

COST OF AN EFFECTIVE H.P. PER YEAR OF 1,000 WORKING HOURS. THE ENGINE WORKING REGULARLY WITH NEARLY FULL LOAD.

	Indicated H.P. of engine.			
	1	10	50	200
	£	£	£	£
Interest, at 5 per cent., on engines, boilers, and buildings...	4·00	2·00	1·50	1·25
Maintenance and depreciation at 7½ per cent	8·00	3·00	2·25	1·88
Coal at 20s. per ton	5·13	3·12	1·56	1 01
Petty stores	0·50	0·30	0·20	0·15
Labour	6·25	3·00	0·80	0·70
Total cost of one effective H.P. per year of 1,000 hours	23·88	11·42	6·31	4·99
Cost (in pence) per effective H.P. hour	5·75	2·84	1·51	1·20

COST OF AN EFFECTIVE H.P. PER YEAR OF 3,000 WORKING HOURS. THE ENGINE WORKING REGULARLY WITH NEARLY FULL LOAD.

	Indicated horse-power.			
	1	10	50	200
	£	£	£	£
Interest, at 5 per cent., on engines, boilers, and buildings...	4·00	2·00	1·50	1·25
Maintenance and depreciation at 7½ per cent.	6·00	3·00	2·25	1·88
Coal at 20s. per ton	15·39	9·36	4·68	3·03
Petty stores	0·75	0·45	0·30	0·25
Labour	12·50	6·00	1·50	1·20
Total cost of an effective H.P. per year of 3,000 working hours, in pounds	38·64	20·71	10·23	7·61
Cost of an effective H.P. hour, in pence	3·10	1·66	·82	·61

It will be useful to place alongside these estimates of the cost of a steam horse-power an estimate of the cost of a horse-power obtained from a gas engine. For comparison, the very careful estimate of Prof. Witz may be taken, based on experimental trials of an engine of 112 indicated horse-power, or 77 effective horse-power, worked with Dowson gas. The total cost of the engine, with pump and pipes, was £944, or £8·2 per indicated horse-power. The gas generator cost £280, or £2·5 per indicated horse-power. Foundations and erection (without buildings) cost £68, or £0·61 per indicated horse-power. The total cost, without buildings, was, therefore, £11·5 per indicated, or £17·2 per effective horse-power, a cost about equal to that of a steam engine plant of the same power. Prof. Witz takes the cost of anthracite at 25s. a ton, and coke at 28s. a ton. He allows for interest and depreciation 15 per cent. The gas consumption is taken at 84 cubic feet per effective horse-power hour, which allows nothing for irregular working. Prof. Witz's figures are reduced to a year of 3,000 working hours.

COST OF AN EFFECTIVE H.P. IN A GAS ENGINE, USING DOWSON GAS, PER YEAR OF 3,000 WORKING HOURS.

Interest and depreciation at 15 per cent.... ...	£2·78
Anthracite and coke...	2·36
Petty stores	·40
Wages	·96
	6·50

The cost appears to be slightly less than that of a steam engine of corresponding power. The cost is equivalent to 0·51d. per effective horse-power hour.

COST OF STEAM-POWER IN CENTRAL STATIONS.

The case of a central station, worked by steam-power, differs from those previously considered in consequence of the excess of plant required, and the waste due to working against a varying load.

Working Cost of Engines Reckoned also at per Indicated Horse-power at Full Load.—The cost of coal will be taken at 7s. per ton. The cost of oil and petty stores will be taken at £0·28 per indicated horse-power per year. Labour is a difficult item to estimate, because it depends so much on management and conditions of working. The cost of labour will be taken at £2 per indicated horse-power. The following rates will be assumed for interest and depreciation:—

	Per cent.
Interest on capital cost of plant	4
Maintenance and depreciation:—	
Buildings	2
Machinery	7½

The annual cost of a horse-power depends on the distribution throughout the day of the work to be done. If the work is regular, and the engine works at nearly full load, the cost of the horse-power is comparatively small; on the other hand, if the work is very irregular, larger engines are required, the working is inefficient, and the cost is comparatively large.

Two limiting cases will be considered:—

Case I.—Conditions similar to those of an engine pumping to reservoirs night and day all the year round. Such an engine may be taken to work 90 per cent. of the whole year, or of 7,884 hours in the year. For one effective horse-power of work done, there must be exerted 1/0·85 = 1·176 indicated horse-power, allowing for engine friction. And for every 1·176 indicated horse power, engines of 1·47 indicated horse-power must be provided to allow the necessary reserve.

Case II.—Engines working in conditions similar to those of an electric lighting station. The engines work all through the year, but the maximum demand is four times the average demand. For every effective horse-power the engines must exert (neglecting the variation of mechanical efficiency) 1·176 indicated horse-power, and for every 1·176 indicated horse-power of average demand, there must be provided engines capable of exerting 4·70 indicated horse-power during hours of maximum demand. Further, to allow a reserve, the engine power in the station must be 5·87 indicated horse-power for every effective horse-power of average demand.

Case I.—Engine working on a very regular load, in conditions similar to those of an Engine pumping to a Reservoir.—Here, for one effective horse-power exerted during 7,884 hours annually, engines of 1·47 indicated horse-power must be provided. Such engines may be taken to use 14 lbs. of steam per indicated horse-power in test trials. But in ordinary work, 7½ per cent. more must be allowed for leakage, working auxiliary engines, and less careful attention. This makes the consumption 15 lbs. of steam per indicated horse-power, or 15 × 1·176 = 18 lbs. per effective horse-power hour. At 9 lbs. of steam per pound of coal, allowing also 5 per cent. for lighting and banking fires, the engine would use 2·1 lbs. of coal per effective horse-power hour. There are very few engines working with quite so low a consumption.

Cost of Installation.

Cost of engines for 1 effective horse-power, or with reserve, 1·47 indicated horse-power = 1·47 × 8·9	£13·3
Cost of boilers = 1·47 × 4·8	7·0
Cost of buildings 1·47 × 6·0	8·8
Total	£29·1

Annual Cost of Working per Effective Horse-Power.

Interest at 4 per cent.	£1·164
Maintenance and depreciation:—	
Buildings at 2 per cent.	0·176
Machinery at 7½ per cent....	1·522
Total fixed annual cost	2·862
Coal, 2·1 lbs. for 7,884 hours, at 7s. per ton ...	2·587
Petty stores	0·327
Driving, stoking, and cleaning	2·334
Total annual cost	£8·110

This is equivalent to 0·24 pence per effective horse-power hour.

Case II.—Engines working with very variable load, in conditions similar to those of an Electric Lighting Station.—Here, for one effective horse-power supplied, on the average throughout the year, engines of 5·87 indicated horse-power have to be provided. On account of the inefficiency and waste due to the variation of the load, it is best to estimate the steam and coal from experience in similar cases. Probably, no electric lighting station at present works with quite so low a consumption as 6 lbs. of coal per hour per electrical unit supplied. A consumption of 9 lbs. is probably much more common in the best managed stations. Six pounds of coal per electrical unit corresponds to 3 8 lbs. per effective horse-power hour.

Cost of Installation.

Cost of engines for one average effective horse-power, with reserve 5·87 indicated horse-power = 5·87 × 8·9	£52·2
Cost of boilers = 5·87 × 4·8	28·5
Cost of buildings = 5·87 × 6·0	35·2
Total cost	£115·9

Annual Cost of Working per Effective Horse-Power.

Interest at 4 per cent.	£4·64
Maintenance and depreciation:—	
Machinery, at 7½ per cent.	6·05
Buildings, at 2 per cent.	0·70
Total fixed annual cost	11·39
Coal, 3·8 lbs. for 8,760 hours at 7s. per ton ...	5·20
Petty stores	0·33
Driving, stoking, and cleaning	2·33
Total annual cost	£19·25

This is equivalent to 0·51 pence per effective horse-power exerted on the average throughout the year.

Cost of a Horse-Power at existing Electric Lighting Stations.—It is, perhaps, not entirely fair to take the cost of working of electric lighting stations as a guide to the cost of steam power. They have been recently established; they work under difficult conditions, and the best methods of economising cost have probably not yet been arrived at. On the other hand, they are central stations of the kind discussed in these lectures, and accounts of the cost of working are published in returns made to the Board of Trade.

To be as fair as possible to electrical engineers, the case of Bradford may be taken, where, according to the returns, a unit of electricity supplied is generated more cheaply than at any other station. In dealing with the figures in the returns, the cost under the heading, "Salaries of manager, engineer, &c.," and that under the heading, "Redemption fund," are discarded. Further, half the cost under the headings, "Depreciation" and "Repairs and maintenance," is also subtracted, because under these headings are included charges not belonging to the cost of generating power. It would not make much difference if a larger or smaller fraction had been subtracted. After making these deductions, the cost of a unit of electricity supplied at Bradford mainly, if not entirely, attributable to the cost of producing power is 2·1d. Now, the mechanical value of an electric unit is 1·34 horse-power hours. Taking the average efficiency of the dynamo at 0·85, then one unit corresponds to 1·34/0·85 = 1·57 effective horse-power of the engine. Calculated on this basis, it appears that the cost of an effective horse-power per year of 8,760 hours, at Bradford, is £49. The cost of coal and petty stores alone, exclusive of all charges for labour, interest and depreciation, is £14·6. At most other stations for which returns are made, the cost reckoned in the same way is considerably greater.

NEW PATENTS—1893.

17,025. "Improvements in raising and lowering the light of electric glow lamps." T. B. SHARP. Dated September 11th.

17,030. "Improvements in apparatus for facilitating the erection or fastening of electrical conductors in wood casings." G. ST. JOHN DAY and W. H. WHEELER. Dated September 11th.

17,045. "Improvements in or relating to electric clocks, part of such invention being also applicable for other purposes." J. H. GASH and J. SKILBECK. Dated September 11th.

17,052. "Improvements in arc electric lamps." W. J. DAVY. Dated September 11th.

17,093. "Improvements in or relating to electric telephones." T. SLOPER. Dated September 12th.

17,127. "Improvements in electrolytic cells." T. CRANEY. Dated September 12th. (*Complete.*)

17,172. "Improvements in air and water tight covers for junction boxes, used in electrical distribution and for other purposes." S. W. BAYNES. Dated September 13th.

17,175. "Improvements in or relating to electric telephones and microphones." T. SLOPER. Dated September 13th.

17,189. "Improvements in electric switches." J. M. M. MUNRO and J. MCFARLANE. Dated September 13th.

17,197. "Improvements in dynamo-electric machinery." R. E. B. CROMPTON and S. L. BRUNTON. Dated September 13th.

17,220. "Improved methods of recovering zinc from the waste products of galvanic batteries." C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. Dated September 13th. (*Complete.*)

17,221. "New or improved galvanic batteries." C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. Dated September 13th. (*Complete.*)

17,234. "Improvements in electric switches for series circuits." A. A. GOLDSTON. Dated September 13th.

17,310. "Improvements in contact apparatus for receiving currents from overhead conductors on electric railways." SIEMENS BROS. & Co., LTD. (Communicated by Siemens & Halske, Germany.) Dated September 14th.

17,330. "Improvements in holders for incandescent electric lamps." J. W. EDMUNDSON and F. J. SATCHWELL. Dated September 14th.

17,341. "Improvements in alternate-current dynamos." G. KAPP. Dated September 15th.

17,348. "Improvements in electrical transformer street surface boxes." H. W. BOWDEN and W. BOBY. Dated September 15th.

17,352. "Improvements in electrically controlled arc lamps." T. T. SCHMIDT. Dated September 15th.

17,372. "Improvements in magneto-electric motors." H. LUDEKE, E. L. A. LUDEKE, A. J. THORMAN, E. DE BUNSEN and E. M. HORE. Dated September 15th.

17,445. "Improvements in pipe conduits for electric mains." W. H. SCOTT. Dated September 16th.

17,466. "Improvements in the treatment of zinc produced by electrolysis." W. WRIGHT and J. B. HAMOND. Dated September 16th.

17,493. "Improvements relating to thermo-electric batteries and to apparatus for use in the manufacture of the same." J. B. C. DION. Dated September 16th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

982. "Improvements in or connected with the manufacture or production of chloride of zinc and alkaline or alkaline earth sulphates, and of zinc and chlorine, by electrolysis of solutions thereof." T. PARKER, A. E. ROBINSON, and C. H. PARKER. Dated January 16th. The inventors roast together sulphide of zinc, or zinc blende, and the chloride of an alkali, or of an alkaline earth, such as chloride of sodium, or chloride of magnesium, and thereby form chloride of zinc and sulphate of the alkali or of the alkaline earth. By making these into a solution, and treating it electrolytically, they obtain therefrom zinc and chlorine. 3 claims.

2,312. "Improvements in shade carriers for electric lamps." B. M. DRAKE, J. M. GORHAM and J. SAWORD. Dated February 6th. A thin brass barrel is made to screw over the standard thread on the barrel of lampholder; two lugs are extended from the bottom of the barrel, and turned out at the bottom. Over the barrel is placed a spiral spring with a brass washer on the bottom end, and also a washer at top. Two or more slots are cut at or near the edge of the hole at top of shade, which allow of the shade to be passed up over the turned up lugs. A quarter turn is then given to the shade, and the spring then presses the shade against the projecting lugs, and holds it rigidly in position. 2 claims.

3,538. "Improvements in distributing and controlling electric currents in mines or other dangerous places." R. J. CHARLETON and H. WALKER. Dated February 23rd. In case of accident to the main cables, either concentric or separate, causing the insulation to be torn asunder, a centre wire, being straight, would be broken immediately, and before those forming the remainder of the conductor (being arranged spirally) would be subjected to any strain. As the circuits are at the generating dynamo carried round a solenoid in reverse directions, the result would be that one circuit round the solenoid would be broken, the balance being therefore destroyed, the current round the other circuit would at once exert a pull on the iron core, and this, bringing the contact maker into action, would short-circuit the main leads, and at the same time would release the trigger, and cut off by the switch the main circuit and to stop the flow of current, without any spark at the point of danger. 3 claims.

4,190. "Improvements in electrical batteries." F. M. A. LAURENT-CELY and E. FINOT. Dated March 3rd. The positive element or plate of the battery consists of a sheet or frame of lead with openings into which peroxide of lead is pressed. The negative element or plate is amalgamated zinc. 3 claims.

4,248. "Improvements in arc electric lamps." J. BROCKIE. Dated March 3rd. Relates to a construction of arc electric lamp and regulating mechanism for the proper control of the carbons in such manner that the lamp is less liable to derangement, requires less attention as to cleaning, is more compact, that the regulation is more certain, and the voltage at the carbon points is kept more uniform than in lamps usually employed. 2 claims.

4,276. "Improvements in electric meters." R. W. PAUL. Dated March 4th. The inventor constructs a galvanometer with suspended coil moving between the poles of a magnet, as in the type of galvanometer commonly called the D'Arsonval, the coil being preferably suspended by a flat strip of phosphor bronze through which the current passes into the coil, leaving it by a spiral below, after the manner recently published. To render the instrument more portable, and the moving parts self-contained, the inventor encloses the coil in a tube, preferably of silver, so as to act as an efficient damper of vibrations; at one end of the tube is an attachment for carrying the mirror or other index and the suspending strip, while the other end is provided with an insulated pin through which the current may pass to the spiral below. 4 claims.

4,427. "Improvements in switchboard systems for telephone exchanges." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago.) Dated March 5th. Comprises an annunciator having two electro-magnets or helices arranged to act differentially upon an armature common to both, adapted to operate an indicator when actuated, and circuit connections, including one of said electro-magnets in the line circuit or in a branch thereof, and the other in a branch from one side of the line circuit to a contact piece adapted to be connected to the other side thereof when a connection is made to line, whereby the two helices are placed in parallel when the connection is made. 7 claims.

4,428. "Improvements in switchboard systems for telephone exchanges." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago.) Dated March 5th. Comprises:—First, an annunciator having two magnets or helices, one adapted to operate an indicator when energised, and the other adapted to reset or restore said indicator to its normal position when energised, and to retain it in such position during its energisation, circuit connections, including the first mentioned helix in the line circuit or in a branch therefrom, and other circuits, including the second helix with a source of electricity in a normally open local circuit adapted to be closed by the act of making connection to the line; second, in a similar two-coil annunciator having its operating helix included in circuit with the connecting cords used for establishing connections between different lines, and its restoring coil in a local circuit, including a source of electricity, and normally open at contact points, adapted to be closed by the operation of connecting the operator's telephone to the cord circuit; third, in the arrangement of parts and circuit connections, whereby the operation of closing the local circuit of the annunciator of a line serves also to alter the electrical condition of the test pieces of the jacks of that line, enabling an operator at another section of switchboard to determine whether the line is already in use or not. 16 claims.

4,429. "Improvements in switchboard systems for telephone exchanges." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago.) Dated March 5th. Comprises contact pieces upon the different jacks of the line adapted to be crossed together by a suitable contact piece upon the connecting plug, corresponding contact pieces upon the different jacks being connected together, and novel means for determining at any spring jack when the said contact pieces are short circuited at some other jack. Said means consist of a testing plug having two contact pieces which are adapted to make contact with the said contact pieces of the spring jack, a telephone receiver in a circuit between the two contact pieces of the testing plug, and a source of telephonic undulatory current in a parallel circuit with the telephone. This source of telephonic undulatory current will then normally create a continuous and preferably slight disturbance in the telephone receiver; but the current will be wholly shunted from the telephone when the testing plug is inserted into the spring jack of a line already in use, through the contact pieces of the testing plug, corresponding contact pieces of the spring jack tested, and the cross connection between the contact pieces of the jack in which a connecting plug is present. 4 claims.

4,768. "Improvements in electric batteries." S. W. MAQUAY. Dated March 10th. The zinc plates are attached to screw plugs or caps, adapted, when in place, to hold the plates in the battery cell, and at the same time to prevent any escape of liquid therefrom. When the battery is not in use the plates are removed from the cells and secured in suitable cavities attached to, or forming part of, the battery. Said cavities or recesses are closed by corresponding vulcanite or like plugs when the battery is in use, and when not in use said plugs are employed to close the openings into the battery. 2 claims.

5,750. "Switch for Electrical circuits." E. H. JOHNSON. (Under International Convention.) Dated August 25th, 1891. In this snap switch the contacts are preferably rigid plates or blocks, instead of yielding springs, and when the switch is operated to close the circuit, the contacts are firmly wedged together and held between two rigid or unyielding surfaces or bodies, as in a vice, the spring which is designed to throw the movable contact exerting its whole force to wedge the contacts together. 18 claims.

8,987. "Improvements in secondary batteries and accumulators." P. GERMAIN. Dated May 12th. Each electrode of this accumulator consists of three plates of lead or lead alloy placed face to face, one against the other, and solidly joined together. The two outer plates are identical and symmetrically disposed. They consist of an external frame with internal divisions, the shape of which being such as to prevent the active substance filling the divisions from falling from the inside to the outside of the plate. The distance of the two outer plates is fixed by a third plate consisting of a combination of vertical and horizontal bars; the space between these bars being the same as the space of the divisions of the two outer plates. 11 claims.

10,466. "An improved telephone combination." Sir C. S. FORBES. Dated June 1st. Consists in an improved form of telephone combination for domestic or other use.

15,994. "Improvements in electrical conductors, particularly applicable to commutator brushes and arc light pencils." P. H. HOLMES. Dated September 6th. The main feature of the invention consists in so making the conductor that it will be stratified or laminated, and the strata will be disposed in planes parallel with what may be termed the direction of flow of the electrical current through the conductor when it is used as or in an electric circuit. 3 claims.

17,751. "A door lock switch for electric lights." G. F. REDFERN. (A communication from C. Green, of Toronto.) Dated October 5th. Consists, essentially, of preferably locating within the keeper opposite the lock of the door a switch which is actuated by a bolt when it is shot into the keeper, so as to extinguish the light when the door is locked by breaking the circuit passing through the wires which lead through the divided plates at the inner end of the keeper to the electric light, the said switch forming when the door is unlocked a means of connection between the divided plates in order to complete the circuit to the light. 2 claims.

18,844. "Improvements in dry cells or galvanic batteries." Dr. H. KOLLER. Dated October 20th. The diaphragms employed in these dry cells consist of perforated sheets of waterproof insulating material such as gutta-percha paper, paraffined paper, or paper saturated with wax. The gelatinous plates or masses of exciting material inserted between the electrodes or plates of the cells, consist of agar-agar, mixed with a metallic salt or salts suitable for causing electrical excitation, the said gelatinous plates being separated by the aforesaid diaphragms. 1 claim.

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